
Final Basis of Design Report

Buffalo River Area of Concern Buffalo, New York

Volume 1

Final Design for Sediment Remediation

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* Due to large file sizes, the Appendixes are included as separate PDFs.

Acronyms and Abbreviations

AOC	area of concern
BMP	best management practice
BODR	Basis of Design Report
BUI	beneficial use impairment
CAA	Clean Air Act
CDF	confined disposal facility
CFR	<i>Code of Federal Regulations</i>
COC	contaminants of concern
CWA	Clean Water Act
DMU	dredge management unit
EFDC	Environmental Fluid Dynamics Code
FS	feasibility study
ft ²	square feet
GAC	granular activated carbon
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
GLWQA	Great Lakes Water Quality Agreement
GPS	global positioning system
mg/kg	milligrams per kilogram
ng/L	nanograms per liter
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCT	project coordination team
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RM	river mile
SEQR	State Environmental Quality Review
SHPO	State Historic Preservation Office
SPDES	State Pollutant Discharge Elimination System
SWPPP	Stormwater Pollution Prevention Plan
TOC	total organic compound

TSCA	Toxic Substance Control Act
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
yd ³	cubic yards

SECTION 1

Introduction

This final basis of design report (BODR) Volume 1 for the remediation of sediment in the Buffalo River Area of Concern (AOC) has been prepared for the U.S. Environmental Protection Agency (USEPA) under CH2M HILL's Contract No. EP-S5-06-01. The BODR includes the elements specified in the Statement of Work for Work Assignment No. 146-RDRD-1524 and is divided into the following sections:

- Section 1—Introduction
- Section 2—Remedial Design Components
- Section 3—Project Delivery Strategy
- Section 4—Design Approach, Assumptions, and Parameters
- Section 5—Compliance with Applicable Requirements
- Section 6—Performance Monitoring and Operations and Maintenance Requirements
- Section 7—Construction Schedule
- Section 8—Biddability, Constructability, and Operability Review
- Section 9—Specifications
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- Tables
- Figures

Volume 2 addresses the design for habitat restoration and capping in the City Ship Canal. The appendixes provide supplemental information integral to the design of the preferred sediment remedy and habitat restoration. The appendixes consist of the following:

- Appendix A— Summary Data Tables and Figures from Investigations in the Buffalo River AOC
- Appendix B—Final Design Drawings
- Appendix C—Specifications
- Appendix D—Design Calculations
- Appendix E—Construction Schedule
- Appendix F—Permits
- Appendix G—Compensation Schedule
- Appendix H—Monitoring Plans
- Appendix I—USACE Reports
- Appendix J—Application for CDF Use
- Appendix K—Critical Structure Approach

Multiple agencies and organizations have been involved in the investigation of and remedial planning for the Buffalo River AOC, including USEPA's Great Lakes National Program Office (GLNPO), the New York State Department of Environmental Conservation (NYSDEC), Buffalo Niagara Riverkeeper, the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), Honeywell International, Inc., City of Buffalo, and their respective consultants. Collectively, the members comprise the project coordination team (PCT), and project decisions are made through discussions with the entire team.

1.1 Site Description

The Buffalo River AOC is located in the city of Buffalo in western New York State (Figure 1). The river flows from the east and discharges into Lake Erie near the head of the Niagara River. A portion of the Buffalo River is designated as a federal navigation channel and is maintained by USACE at a depth of 22 feet below low water datum. The AOC includes the entire 1.4-mile stretch of the City Ship Canal that adjoins the river just upstream of the river confluence with Lake Erie, and extends upstream approximately 6.2 miles as shown in Figure 1. The AOC is regarded as the "impact area" and is characterized by historically heavy industrial, commercial, and public

development in the midst of a large municipality. Since the early 1800s, municipal and industrial waste has been disposed of in the Buffalo River, including pollution from grain milling and manufacturing industries along the shoreline. According to USACE, the pollution problems were compounded with the widening and deepening of the river for navigation, which increased hydraulic residence time and sedimentation (USACE 2010).

The Buffalo River sediments have been impaired by past industrial and municipal discharges that have resulted in elevated levels of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and various metals.

1.2 Beneficial Use Impairments

In 1987, amendments to the Great Lakes Water Quality Agreement (GLWQA) were adopted by the federal governments of the United States and Canada. Annex 2 of the amendments listed 14 beneficial use impairments (BUIs), which are caused by a detrimental change in the chemical, physical, and/or biological integrity of the Great Lakes system (International Joint Commission 1988). The Annex directed the two countries to identify AOCs that did not meet the objectives of the GLWQA. Remedial action plans addressing the BUIs were to be prepared for all 43 AOCs identified, including the Buffalo River. The BUIs provided a tool for describing the effects of the contamination and a means for focusing remedial actions.

The most recent Buffalo River Remedial Action Plan Status Report identified 9 of the GLWQA's 14 beneficial uses as being impaired or likely impaired (Buffalo Niagara Riverkeeper 2008). The following are the BUIs:

- Restrictions on fish and wildlife consumption
- Tainting of fish and wildlife flavor
- Degradation of fish and wildlife populations
- Fish tumors and other deformities
- Bird or animal deformities or reproductive problems
- Degradation of benthos
- Restrictions on dredging activities
- Degradation of aesthetics
- Loss of fish and wildlife habitat

The impairments primarily have been caused by historical discharges to the river from industrial facilities.

1.3 Historical Investigations and Dredging Activities

From 1998 through 2012, GLNPO, in coordination with other federal, state, and local partners, completed a variety of remedial investigations, planning, and feasibility-level studies to evaluate the impacts of contaminated sediments on the aquatic system and determine an appropriate approach to remediating contaminated sediments within the Buffalo River AOC. The investigations are described and results included in the following documents:

- CH2M HILL and Ecology & Environment. 2011a. *Data Evaluation Report – Habitat Restoration; Buffalo River Area of Concern; Predesign Sampling*. February.
- CH2M HILL and Ecology & Environment. 2011b. *Data Evaluation Report – Data Gap Investigation; Buffalo River Area of Concern*. March.
- CH2M HILL and Ecology & Environment. 2011c. *Data Evaluation Report – Intermediate Design Investigation (Addendum to Appendix A of the 2010 Basis of Design Report); Buffalo River Area of Concern*. December.
- ENVIRON International Corporation. 2012. *Critical Structure Focused Investigation for DMUs 11-15; Buffalo River, NY*. January.
- LimnoTech. 2011. *Memorandum: Assessment of Anticipated Sedimentation Rates for Lower Buffalo River Remedy Areas*. October.

- USACE, Buffalo District. 2013. *Sediment Sampling Summary Report; Buffalo River Area of Concern; Eastern and Western CSX Bridge Evaluation*. January.

In 1997, during construction of a cap and a slurry wall around the perimeter of a peninsula of land formerly owned by the Buffalo Color Corporation (currently owned by South Buffalo Development and identified as Area D by NYSDEC; Figure 4), contaminated material was identified in the Buffalo River at river mile (RM) 4.6. Although most of the contaminated material has been removed and placed within the confines of Area D, a portion of sediment could not be removed because of the potential damage to the slurry wall. The remaining portion of contaminated sediment in the river at RM 4.6 has been capped with a geotextile layer, sand, and a surface layer of shot rock and riprap (ENVIRON et al. 2010).

In 2005 and 2007, GLNPO and NYSDEC conducted sediment sampling in the Buffalo River AOC as a part of a remedial investigation (NYSDEC 2006, NYSDEC 2008). Approximately 202 surface sediment samples and 270 subsurface sediment samples were collected and analyzed for PAHs, PCBs, pesticides, total organic carbon (TOC), volatile organic compounds, and select metals. Also, 25 surface samples and 20 subsurface samples (0.5 to 1 foot) were collected and analyzed for acid volatile sulfide and simultaneously extracted metals (ENVIRON et al. 2009). The surface samples were collected to evaluate the recently deposited sediments in the center of the navigational channel and stream banks, while the subsurface samples below the dredged depth of navigational channel were collected to evaluate the contamination from historical industrial activities. During 2005 and 2007, another 26 sediment samples were collected and analyzed to evaluate the potential toxicity of sediments to the freshwater fauna. The 2007 sampling event also included 25 samples analyzed for geotechnical properties to evaluate the physical characteristics of the sediment (USACE 2010).

During the fall of 2008, GLNPO conducted additional sediment sampling to supplement the 2005 and 2007 investigation results and to refine the delineation of the distribution of chemical concentrations in the river sediments, both laterally and vertically. Approximately 208 surface sediment samples and 271 subsurface sediment samples collected in fall 2008 were analyzed for concentrations of PAHs, PCBs, lead, and mercury (ENVIRON et al. 2009), which were identified as the four primary indicator chemicals based on the previous investigations (USEPA 2008). The samples collected in 2008 were also analyzed for TOC and particle size distribution.

During the 2005, 2007, and 2008 investigations, sediment samples from 25 locations were analyzed for alkylated PAHs. In addition to collection of whole-sediment samples, surface sediment samples from 20 locations were collected for analyses of pore water PCB congeners and pore water parent and alkylated PAHs (ENVIRON et al. 2009).

The chemical and physical results were used to develop a range of alternatives to address the contaminated sediment. The data were also used to define distinct dredge management units (DMUs) that will be used to manage the sediment remediation (Figures 2 and 3).

Based on the initial range of alternatives, the PCT identified additional information needed to finalize the evaluation of alternatives, enable identification of the preferred remedial alternative, and to support the development of the preliminary design of the sediment remediation and habitat restoration activities. In August 2010, a predesign investigation was conducted to fill the data needs related to refining the horizontal and vertical extents of the dredge footprints and resample areas, collecting geotechnical properties for cap design, to support the habitat restoration design and to characterize material that would be disposed of in the existing confined disposal facility (CDF). Investigation activities also included the completion of a survey of the critical structures (critical structures are described in Section 2.2.1) and shoreline properties that may be impacted by the remediation effort.

The development of the preliminary design in March 2011 identified that additional data were needed to refine the proposed dredge boundaries and sediment volumes and the locations and extents of debris, riprap, and utilities. The investigation was conducted in August 2011 and included geophysical surveys, additional chemical sampling, and survey of structures.

In October 2012, surficial sediment samples were collected by USACE near the railroad bridges owned by CSX. The samples were collected to provide additional surface sediment data near the bridges and determine if monitored natural recovery can be applied as a remedial approach (CH2M HILL and Ecology & Environment 2012).

The USACE Buffalo District performs annual surveys and maintains the federal navigational channel as identified in Figures 2 and 3. In order to maintain the authorized depth of 22 feet below low water datum, approximately 140,000 cubic yards (yd³) of sediment is typically dredged on average every 2 years. Almost 1 million yd³ of sediments have been removed from the harbor over the past 18 years (USACE 2010). In 2011, USACE dredged 452,093 yd³ of sediment from the federal navigation channel in advance of the environmental dredging described in this final BODR (see Figure 4 for USACE dredge areas). In addition, between 2011 and 2012, USACE dredged a total of 97,539 yd³ outside of the Great Lakes Legacy Act (GLLA) project boundaries for regular operation and maintenance purposes (USACE 2012).

1.4 Project Objectives

The primary objective of the overall project is to remediate the Buffalo River AOC by a combination of capping, removing the contaminated sediments, and habitat restoration to support lifting the BUI designations. The following are remedial action objectives developed by the PCT and are also presented in the draft final feasibility study (FS) report (ENVIRON et al. 2010):

- Reduce human exposure for direct sediment contact and fish consumption from the Buffalo River by reducing the availability and/or concentrations of the contaminants of concern (COCs) in sediment.
- Reduce the exposure of wildlife populations and the aquatic community to sediment COC concentrations above protective levels.
- Reduce or otherwise address legacy sediment COC concentrations to improve the likelihood that future dredged sediments (for routine navigational, commercial, and recreational purposes) will not require confined disposal.
- Implement a remedy compatible with the Buffalo River Remedial Advisory Committee's goal of protecting and restoring habitat and supporting wildlife.
- Along with the remedial action objectives, supportive goals were considered during the assessment of remedial alternatives, such as the following:
 - Reduce the long-term potential of COC contaminated sediments to migrate outside of the Buffalo River AOC.
 - Implement a sediment remedy that is compatible with and complements ongoing regional redevelopment goals, upland remediation, and restoration activities.

1.5 Description of the Preferred Remedy

In December 2010, the FS report was released to the public for comment. The FS presents the evaluation of dredging, capping, and restoration technologies that would address the contamination. Five alternatives were developed that aimed to efficiently and effectively achieve the sediment-related ecological and human health remedial action objectives. Remedial Alternative 5, Enhanced Protectiveness Dredging, was recommended as the preferred remedial alternative.

Alternative 5 specifically targets the removal of areas that exceed the site-specific sediment chemistry guidelines, including elevated chemical concentrations at depths between 0 and 4 feet, and areas associated with the presence of oil and grease. The preferred remedy will also reduce risks to human health and the environment in areas frequently accessed by the public, in sediment areas that may scour during high-flow events, and in areas where sediment has been historically disturbed by ship traffic.

Many of the identified impairments of the beneficial uses in the Buffalo River AOC are directly related to the contaminated sediment and the impaired local habitat. Table 1 provides the information on how the selected remedy will restore the area's ecological integrity and address the BUIs.

The proposed remedial action consists of a combined remedy of sediment removal by mechanical dredging, capping of contaminated sediment where removal of sediment could compromise the stability of shoreline structures, and aquatic habitat restoration upon completion of dredging activities (some areas with contaminated sediment adjacent to shoreline structures will not be capped because the slopes are too steep). Approximately 412,000 yd³ of non-Toxic Substance Control Act (TSCA)-level sediments¹ (total PCB concentrations less than 50 parts per million [ppm]) from the Buffalo River and approximately 50,000 yd³ of non-TSCA-level sediment from the City Ship Canal will be mechanically dredged and disposed of at the existing USACE CDF No. 4, which was specifically designed for the management and disposal of the Buffalo River sediments. Note that the FS reported that an estimated 720,000 yd³ and 100,000 yd³ of contaminated sediment would be dredged from the Buffalo River and City Ship Canal, respectively, but the volumes have been updated based upon the additional data collected in 2010 and 2011, discussions with the PCT and the USACE dredging completed in 2011. Also, 4,200 yd³ of TSCA-level sediment was estimated to be removed from the Buffalo River.

USACE's CDF No. 4 is located in the outer Buffalo Harbor adjacent to the south entrance channel to the harbor (approximately 3 miles from the downstream end of the project area (Drawing CD-1 in Appendix B). Additional information regarding the CDF is provided in Section 4.4.

The mechanically dredged sediments will be loaded in hopper barges and transported to an area set up for debris removal at the CDF. Once the loaded hopper barge reaches the debris removal area, debris will be picked out, and the hopper barge will be moved to the mooring and pump-out facilities at the CDF. The sediments will be hydraulically pumped from the barge into the CDF. In order to minimize the flow of water exiting from the CDF, supernatant water in the CDF will be mixed with the sediment in the hopper barge to create a pumpable solids slurry. A small volume (approximately 4,200 yd³) of TSCA-level sediments (total PCB concentrations greater than 50 ppm) will be mechanically dredged, stabilized, managed, and disposed of offsite at a TSCA- (and Resource Conservation and Recovery Act [RCRA]-) permitted facility. The TSCA-level sediments are located in DMU-08b (Figure 2).

The contaminated sediments at the southern end of the City Ship Canal (beyond the limits of the federal navigational channel) exist in a low-energy environment that is not susceptible to sediment scour from overlying flow, ice events, propeller wash, or navigational dredging. Approximately 290,000 square feet (ft²) of sediment in the City Ship Canal will be capped to isolate contaminants and provide a clean sediment surface and an appropriate substrate for habitat restoration in this part of the AOC. Areas to be capped are identified in Figures 2 and 3.

Following dredging and capping activities, bathymetric surveys will be completed.

The remedial action consists of the following key components:

- Mobilizing equipment and personnel.
- Constructing (or improving existing) haul roads, staging areas for capping materials and TSCA-level sediment stockpiling, and temporary barge mooring and access structures (if necessary).
- Installing turbidity monitoring equipment in the river.
- Performing a bathymetric survey to document the pre-dredge sediment conditions.
- Mechanical dredging of approximately 462,000 yd³ of non-TSCA-level sediments following best management practices (BMPs) and loading the sediment into watertight hopper barges.
- Transporting loaded hopper barges to a debris staging area at the CDF for debris removal.
- Transporting loaded hopper barges to the sediment offloading area at the CDF.

¹ By definition, materials regulated under the Toxic Substance Control Act with greater than 50 parts per million total PCB concentrations are also classified as hazardous by the New York Environmental Conservation Law (which implements the Resource Conservation and Recovery Act). The sediments being remediated under this project that contain greater than 50 ppm PCBs are associated with waste code B007. Therefore, sediments containing greater than 50 ppm are referred to as TSCA-level materials within this document and are also RCRA hazardous. Non-TSCA-level materials are not classified as RCRA hazardous under waste code B007.

- Mixing sediment on the hopper barges with the free water from the CDF to create a slurry and pumping the sediment slurry into the CDF.
- Mechanical dredging of approximately 4,200 yd³ of TSCA-level sediments, stabilizing the sediments, and transporting the stabilized sediment to a TSCA-permitted landfill.
- Treatment of water generated during the handling of TSCA-level sediments in a temporary onsite water treatment system prior to permitted discharge to the sanitary sewer or the Buffalo River.
- Ongoing monitoring activities, including turbidity monitoring in the river upstream and downstream of dredging activity and air monitoring during handling of TSCA-level sediments.
- Once dredging is completed, performing a post-dredge bathymetric survey to document sediment removal and payment quantities.
- Capping approximately 290,000 ft² of sediment at the southern end of the City Ship Canal to provide chemical isolation of impacted sediments and verifying the cap thickness placed during construction. The City Ship Canal cap is described in the final habitat BODR.
- Separately from the cap placed at the southern end of the City Ship Canal, placement of an armored cap to provide physical isolation over contaminated sediments that will not be dredged because of the possibility of impacting the stability of nearby critical structures (98,700 ft² have been estimated for this task).
- Once capping activities are completed, completing a bathymetric survey to document capping placement and payment quantities.
- Teardown, removal, and offsite disposal of temporary infrastructure.
- Demobilizing equipment and personnel.

Habitat at selected sites will be restored by replacing and augmenting aquatic habitat impacted by dredging. The restoration will serve to fulfill the remedial action objective to “implement a remedy compatible with the Buffalo River Advisory Committee’s goal of protecting and restoring habitat and supporting wildlife” (ENVIRON et al. 2010). The design of the habitat restoration portion of the overall remedy is presented in Volume 2 of the final BODR. The habitat restoration design includes both in-water and riparian components to present a complete restoration plan for the sites. To meet the remedial action objective, the in-water portion of the design will be completed as part of the GLLA project. The in-water portion of the habitat restoration work on the City Ship Canal and Katherine Street Peninsula is considered to be the portion of the project used to mitigate environmental impacts from the dredging activities. The habitat restoration design for riparian planting will not be completed as part of the GLLA project and may be completed by different entities in the future. Components of the habitat restoration design, such as retention of as many pilings as possible, have been incorporated on the dredging design drawings.

Monitoring will be implemented as part of the overall remedy and is described in the *Residuals Monitoring Plan* in Appendix H. The purpose of the monitoring will be to evaluate river sediment conditions 2 and 5 years after remediation.

Remedial Design Components

Section 2 summarizes the technical parameters upon which the design for the mechanical dredging and capping of contaminated sediments is based.

2.1 Sediment Characterization

The analytical data from field investigations completed between 2005 through 2010 were used to define the lateral and vertical extent of the contaminated sediment requiring removal and capping. The following section summarizes the nature and extent of contamination and presents the methods used to interpolate the data set and define the lateral and vertical extent of contamination.

Additional investigation activities were performed in 2011 to refine the elevation of the top of the glacial till layer and native shoreline material beneath soft sediment in the DMUs, which involved collection of sediment samples for visual classification from a barge. In addition to visual determination of till elevation from retrieved samples, the 2011 investigation activities included probing to determine the depth to till in select areas.

2.1.1 Data Summary

Table 2-1 in Appendix A provides the data used for analysis within the Buffalo River AOC and includes data collected by GLNPO and NYSDEC from 2005 through 2010.

In the fall of 2011, a supplemental investigation was conducted that involved geophysical surveys and collection of samples using a vibracore to obtain additional elevation data for the top of native till, identify debris areas and utilities, survey the shorelines adjacent to structures of interest, assess potential archaeological issues associated with the underwater portion of the dredge area, and collect additional sediment samples for chemical analysis to better define dredge boundaries. Additional samples were collected in DMU-08b (TSCA area), DMU-45c (toe of Kelly Island), DMU-45d (Naval Park), DMU-44e (Deadman's Creek portion), DMU-10 (Niagara Frontier Transportation Authority Abandoned Bridge), DMU-38 (National Grid Towers), and a marine slip owned by BIDCO Marine Group, Inc. The results of the investigation are summarized in the following subsections.

2.1.2 Nature and Extent of Contamination

Several investigations were conducted by the agencies to delineate the nature and extent of the contamination (mainly total PAHs, total PCBs, lead, and mercury) within the Buffalo River AOC, as described in Section 1.3.

Site investigations conducted in 2005/2007 and 2008 identified the following:

- Total PAH surface concentrations ranged from nondetection up to 300 milligrams per kilogram (mg/kg), averaging 10 mg/kg. The maximum surface concentration was located in the City Ship Canal. The total PAH subsurface concentrations ranged from non-detection up to 1,800 mg/kg, averaging 29 mg/kg, with the maximum subsurface concentration located between RM 4.5 and 5.0.
- Total PCB surface concentrations ranged from nondetection up to 10 mg/kg, averaging 0.15 mg/kg, with the maximum surface concentration located between RM 4.0 and 4.5. Total PCB subsurface concentrations ranged from non-detection up to 160 mg/kg, averaging 0.7 mg/kg, with the maximum subsurface concentrations located between RM 5.0 and 5.5.
- Lead concentrations in the sediment surface ranged from 1.9 mg/kg to 2,700 mg/kg, averaging 161 mg/kg, with the maximum surface concentration located in the City Ship Canal between RM 0.0 and 0.5. The lead concentrations in the subsurface sediments ranged from 7.5 mg/kg to 8,500 mg/kg, averaging 136 mg/kg, with the maximum subsurface concentration located between RM 4.5 and 5.0.
- Mercury surface concentrations ranged from nondetection to 9.5 mg/kg, averaging 0.28 mg/kg, with the maximum surface concentration located between RM 3.5 and 4.0. The subsurface sediment mercury

concentrations ranged from nondetection to 44 mg/kg, averaging 1.5 mg/kg, with the maximum subsurface concentrations located between RM 5.0 and 5.5.

In addition to the collection of whole-sediment samples, pore water was collected from a subset of 20 surficial sediment samples (0 to 0.5 foot) and analyzed for pore water concentrations of parent and alkylated PAHs and PCB congeners. Thirteen of the 34 parent and alkylated PAHs, typically the higher-molecular-weight PAHs, were not detected in any of the 20 surficial sediment samples. The remaining compounds were typically detected in less than half of the pore water samples. The highest total PCB concentration (sum of all 52 congeners) measured in the pore water was between RM 3.5 and 4.0, which had a total PCB concentration of 13.5 nanograms per liter (ng/L), while all other samples had total PCB concentrations less than 3.8 ng/L. Twelve of the 20 samples had PCB congener concentrations less than 1.0 ng/L (ENVIRON et al. 2009).

In August 2010, GLNPO conducted additional sampling within the AOC to close the data gaps identified in the previous investigations (CH2M HILL and Ecology & Environment 2011b). Portions of the Buffalo River where contamination was present in an isolated sample were resampled to confirm the presence of the contamination and to delineate the lateral and vertical extent of the contamination. The investigation primarily focused on the following three dredge areas: (1) Resample areas, (2) 41 Hamburg Street site, and (3) DMU-08b. A total of 549 samples were collected during the 2010 data gap investigation and were analyzed for PAHs (17 PAHs), PCB Aroclors, lead, and mercury. Total PAH concentrations for all 17 PAHs ranged from 0.035 mg/kg to 2,000 mg/kg. Excluding 2-methylnaphthalene, total PAH concentrations for the remaining 16 PAHs ranged from 0.032 mg/kg to 1,900 mg/kg. All 17 PAHs analyzed were detected, with the most commonly detected PAHs (fluoranthene and phenanthrene) found in 547 of the 549 samples. The total PCB concentrations ranged from 0.052 mg/kg to 230 mg/kg, with Aroclor 1248 being the most commonly detected (found in 202 of 549 samples). Lead was detected in all samples, with concentrations ranging from 5.5 mg/kg to 3,010 mg/kg at an average concentration of 208 mg/kg. Mercury was detected in 509 of the 549 samples. The concentrations ranged from 0.05 mg/kg to 73 mg/kg, and with an average concentration of 3.4 mg/kg. TOC concentrations ranged from 4,910 to 121,000 mg/kg and averaged 30,700 mg/kg. Eighty-six percent of the sediment samples were primarily fine-grained materials (greater than 50 percent silt and clay).

In August 2011, GLNPO conducted additional sampling within the AOC to close the data gaps identified in the preliminary design (CH2M HILL and Ecology & Environment 2011c). Samples were collected at DMUs that were near critical structures or habitat areas to refine the dredge boundaries. In addition, samples were collected at two inlets that were not previously evaluated. Extensive sampling also was completed at the DMU-08b (the TSCA area) to delineate the area with sediment concentrations greater than 50 mg/kg total PCBs. A total of 150 primary samples and 9 field duplicates were collected during the 2011 data gap investigation and were analyzed for PAHs (17 PAHs), PCB Aroclors, lead, and mercury. A total of 129 primary samples and 7 field duplicates were collected in the TSCA area and were analyzed for medium-level, quick-turnaround PCB Aroclors. PAHs were detected in 145 of the 150 samples and total PAH concentrations for all 17 PAHs ranged from 0.03 mg/kg to 220 mg/kg. All 17 PAHs analyzed were detected, and the most commonly detected PAH was pyrene, which was found in 140 of the 150 samples. The total PCB concentrations ranged from 0.018 mg/kg to 3.90 mg/kg outside of the TSCA area and 1.1 mg/kg to 1,200 mg/kg within the TSCA area. PCBs were detected in 77 of the 150 samples outside the TSCA area and 67 of the 129 samples within the TSCA area. Lead was detected in all samples, with concentrations ranging from 3.5 mg/kg to 790 mg/kg and an average concentration of 179 mg/kg. Mercury was detected in 107 of the 150 samples. The concentrations ranged from 0.14 mg/kg to 8.1 mg/kg, with an average concentration of 2.4 mg/kg. TOC concentrations ranged from nondetect to 146,000 mg/kg and averaged 28,000 mg/kg.

Results of the 2005, 2007, 2008, 2010, and 2011 sediment sampling and analysis were combined to determine the lateral and vertical distribution of the total concentrations of PAHs, total PCBs, lead, and mercury in the Buffalo River, City Ship Canal, and Cazenovia Creek. The total PAH, total PCB, lead, and mercury concentrations reported from the sediment investigations up to and including the 2010 data gap investigation are included in Table 2-1 in Appendix A.

Results of the studies indicate that surface concentrations for all four indicator chemicals are typically lower than subsurface concentrations. The trend is clearly demonstrated in the vertical profiles provided for each chemical

along the Buffalo River and the City Ship Canal as presented in the FS and was confirmed by the 2010 and 2011 data gap investigation results. In addition, the average and geometric mean concentrations for each half-mile segment of the Buffalo River and the City Ship Canal are typically greater for subsurface samples as compared to surface samples for total PAHs, total PCBs, lead, and mercury (ENVIRON et al. 2009). The reduced chemical concentration in the surface sediments of the Buffalo River AOC is likely because of the more recent and ongoing deposition of sediments with decreasing chemical concentrations over time.

The Buffalo River AOC is a depositional environment, and sediments with low chemical concentrations originating from upstream of the AOC have likely been transported and deposited within the AOC, creating a lower concentration sediment surface compared to the subsurface sediments. In general, the highest sample concentrations for each of contaminants are located between RM 3.5 and 5.5 and in the City Ship Canal. Chemical concentrations upstream of the AOC, both in the Buffalo River and Cazenovia Creek, are typically lower than the average concentrations in the Buffalo River AOC.

As additional investigations have been conducted (including the 2012 CSX Bridge sampling), and the additional analytical data evaluated, some of the dredge boundaries have been modified, and some potential dredge areas (identified as Resample Areas in the FS) were eliminated from the proposed dredge program. Changes to the dredge boundaries include the following areas (refer to Figures 2 through 5 and the drawings in Appendix B):

- **Transmission towers near Cargill.** The area includes portions of DMU 38 where a set of electrical transmission lines cross the Buffalo River. Based on additional sampling results, the DMU boundaries adjacent to the transmission line towers were offset from the shoreline by 30 feet.
- **Naval Park.** The area is designated as DMU 45d and includes sediments beneath and adjacent to the naval ships anchored at the Buffalo and Erie County Naval & Military Park, and also adjacent to the Commercial Slip area. Based on the additional sampling results, the DMU boundary was revised to eliminate the sediments beneath and adjacent to the naval ships from the DMU.
- **Kelly Island.** The area includes DMU 45c, located at the toe of Kelly Island, where the City Ship Canal joins the Buffalo River. Based on additional analytical sampling results, the area of the DMU outside the navigation channel was designated for no dredging.
- **Resample areas removed from dredge plan.** Several areas were identified in the FS as Resample Areas, due to the lack of analytical data to sufficiently define a dredge boundary. Following additional sampling and analysis in 2010, Resample Areas R-01, R-03, R-08, R-09, R-10, and R-12 were removed from the areas identified for environmental dredging.
- **TSCA/RCRA Area.** The TSCA area is designated as DMU-8b. The original boundary of DMU-8b was established based on the initial core sampling program performed as part of the FS and was defined based on the horizontal and vertical extent of PCBs greater than the regulatory level of 50 ppm. In 2011, additional core sampling was performed to refine the horizontal and vertical extent of TSCA/RCRA material.
- **Dead Man's Creek.** The area is part of DMU-44e and has been expanded to include the inlet area. Following discussions within the PCT, the area within the inlet will be dredged to elevation 545 feet.

2.1.3 Hydrodynamic Model

As part of the 2008 investigation, hydrodynamic and water quality parameters were measured along three transects of the Buffalo River AOC. In addition, bathymetric surveys were conducted upstream of the navigation channel to supplement existing USACE bathymetric data.

The information was used to develop and calibrate models to evaluate the existing hydraulic and hydrodynamic conditions of the AOC. Modeling efforts were performed by ENVIRON, MACTEC, and LimnoTech and summarized in the FS report (ENVIRON et al. 2010). The hydrodynamic model, a three-dimensional Environmental Fluid Dynamics Code (EFDC) model, provides three-dimensional velocity and shear stress distributions along the river over a range of flow conditions. The hydraulic model, a one-dimensional Hydraulic Engineering Center-River Analysis System model approved by the Federal Emergency Management Agency, predicts changes in flood elevation and potential flooding

under various flow conditions and seiche events. The modeling results were used to estimate the critical velocities and forces under various flow scenarios that would be observed along the channel bed within the identified design sites that could potentially affect channel stability and sediment transport.

The velocities and shear stresses computed by the EFDC model for the various flow conditions and events are consistent with the river's function as a dredged navigation channel. Results from model simulations demonstrate low velocities and bottom shear stresses throughout the AOC during low flow conditions. An increase in velocities and shear stress was demonstrated during high-flow events (10-year and 100-year intervals), but the increases were most notable in narrow sections of the river including RM 1.0 to 2.0, RM 2.9, and RM 5.2.

It should be noted that the hydrodynamic modeling was performed for the Buffalo River only. The low flow conditions of the City Ship Canal were not included in the modeling effort.

2.1.4 Bathymetric and Sediment Thickness Surveys

USACE conducted a bathymetric survey of the federal navigation channel in the project area in May 2009. The bathymetric survey was used to develop the contract documents for the 2011 federal navigation channel dredging. USACE also performed a bathymetric survey in September 2010 as well as post-dredging surveys of areas dredged during the 2011 and 2012 dredging as they were completed. The surveys were not included in the final design because they were not complete surveys of the GLLA project area.

Additional bathymetric surveys were performed for GLNPO in 2010 and 2011 that included portions of the project area not covered by the USACE bathymetric surveys. The 2010 survey focused on the shoreline and side-slope area that were too shallow to be surveyed from the water. The 2011 bathymetric survey was done in conjunction with the side scan sonar survey. The survey was combined with the shoreline survey performed in 2010 to create a final surface. In addition, the critical structures were surveyed to accurately locate the edge of the structures in the Buffalo River. The survey points and side scan sonar were used to create an updated shoreline and were used to develop the current conditions drawings (Drawings ED-1 through ED-4 and EH-1 through EH-4) in Appendix B. The basis for the sediment volume calculations was developed from the Current Conditions drawings, incorporating a 40,000 yd³ increase in sediment volume to account for sedimentation over the total dredge footprint between the time of bathymetric survey and remedial activities.

The 2011 supplemental investigation also included collecting sediment thickness data and surveying of top-of-till elevations. The surveys and evaluation process are described in detail in the summary report (CH2M HILL and Ecology and Environment 2011c).

For the dredging activities described in this final BODR, the dredging contractor will be required to perform a pre-dredge bathymetric survey that covers areas to be dredged before performing mechanical dredging work. A post-dredge bathymetric survey will be performed at the conclusion of dredging activities in each DMU to document final conditions and establish payment quantities. Additionally, interim surveys may be conducted to document quantities for month-end invoicing if final surveys for dredged DMUs will not be completed in time. It is expected that GLNPO will contract with an independent party to perform oversight during performance of the two bathymetric surveys and acceptance of the final products. This party is referred to as "GLNPO's representative" in this document.

2.1.5 Contaminated Sediment Volume Results

Appendix D contains a memorandum that describes the development of contaminated sediment volume totals. The volume of contaminated sediment within each DMU is summarized in Table 2.

2.2 Bulkhead/Shoreline Stability

2.2.1 Critical Structures

A total of 21 large structures in the project area were originally designated by the PCT as critical structures before the preliminary design because they are located adjacent to DMUs, and a structural failure could result in a safety hazard. The structures include warehouses, grain elevators, transmission towers, and piers supporting bridges.

Subsequently, a few other shoreline structures have been designated as critical structures, and some of the original critical structures have dropped off the list because additional sampling and analysis have shown DMUs could be modified to avoid potential impacts to the critical structures. A total of 20 critical structures are now located adjacent to or within DMUs with contaminated sediment, as shown in Figure 4.

The preference is to remove contaminated sediment near a critical structure. Due to concerns regarding potential liability when removing soft sediment near critical structures, the PCT agreed to approach owners of critical structures to see if they would agree to sign a liability waiver allowing the dredging to proceed. The process of negotiating liability waivers was iterative; if a critical structure owner did not agree to sign a first draft, in many cases, the PCT developed an alternative approach that would allow partial dredging and capping to be performed. Often, however, no agreement satisfactory to both parties could be reached. It should be noted that owners of critical structures could have had a number of reasons to not sign a waiver, including disagreement regarding language around the legal release, extent of the removal due to valid structural concerns, or financial inability to conduct a structural evaluation.

Where the owner did not allow complete dredging, placement of an armored cap over the sediment was considered. In several cases, however, the existing sediment surface has a relatively steep slope that would be difficult to cap and placement of cap material within the federal navigation channel is not possible; thus, there is no reasonable means to cap this contaminated material. In these cases, a no-dredging zone is identified next to the critical structure that extends a distance of 30 feet upstream and downstream and out to the center of the federal navigation channel. Refer to Appendix K to see where these approaches will be applied.

Table 1 in Appendix K summarizes the process and the approach for each critical structure. Table 2 in Appendix K provides estimates of the contaminant concentrations and sediment volumes remaining following implementation of the remedial activities.

2.2.2 Remaining Shoreline

The shoreline adjacent to the DMUs that is not defined as a critical structure shoreline varies in construction and includes some natural slopes with or without riprap. Improved shoreline consists of concrete capping on top of timber or concrete piles, steel sheet pile cells, concrete pier and timber pile crib walls, steel sheet pile walls, concrete walls, and cut stone walls. Boat docks are also present along a few properties. Engineered shoreline structures such as these are considered non-critical structures, and are generally intended to stabilize the soil, prevent erosion of the shoreline, and provide improved river access to the property. The dredging contractor will be allowed to maintain a maximum 5-foot offset from these non-critical structures to limit the chance of contacting them with the dredging equipment (the 5-foot offset will apply to all shoreline types listed below that are not sloped shorelines). A sloped modification was made to the design cut line for vertical cuts of greater than 5 feet as illustrated on Detail 7 of Drawing DD-2 in Appendix B. For shoreline types that have some sort of engineered protection on a sloping shore, the dredging contractor will be allowed to maintain a maximum 10-foot offset from the toe of the protection to prevent undercutting the engineered protection. Property owners and shoreline classifications are shown in Figure 4 and Table 3.

The shoreline classifications shown in Figure 4 and on Table 3 were grouped by type. The following is a listing of the shoreline groups (abbreviations below correspond with those shown on Figure 4):

- Shorelines with structures on piles. This grouping includes shoreline classifications of Timber Wharf on Timber Piles (TWTP), Concrete Piles and Cap (CCC), Large Diameter Steel Sheet Pile Cells (LD), Steel Sheet Pile with Concrete Cap (SPC), Steel H Piles with Concrete Cap (SHPC), Concrete Pier Crib Wall (CPCS), and Concrete Cap on Timber Piles (CCT).
- Shorelines with removable docks. This grouping includes the shoreline classification Aluminum/Wood Boat Docks (AWB).
- Sloped shorelines or with timbers. This grouping includes shoreline classifications of Naturally Sloped Shore (NS), Old Timber Piles (OTP), and Naturally Sloped Shore with Timber Piles (NST).

- Sloped shorelines with engineered protection. This grouping includes shoreline classifications of Boat Ramp (BR), Naturally and Stone Sloped Shore (NSS), Grouted Sloped Shoreline (GSS), Grouted Sloped Stone Shoreline (GSSS), Cobble, Gravel, and Debris Shoreline (CGDS), Riprap (RPRP), Cobble and Gravel Shoreline (CGS), and Sloped Stone Gabion (SSG).
- Shorelines with walls. This grouping includes shoreline classifications of Concrete Wall (CW), Anchored Steel Sheet Pile Wall (ASP), Cut Stone Wall (CSW), Steel Sheet Pile Wall (unanchored) (SSPW), Stone Filled Timber Crib (SFC), Railroad Abutment (RRA), Anchored Concrete Sheet Wall (AC) and Timber Bulkhead (TB).

The dredging approach for each grouping is shown in the drawing DD-1 in Appendix B.

2.3 Utilities

A design ticket was submitted with Dig Safely New York (Dig Safe NY) on January 4, 2011. The ticket (No. 01041-152-043-00) requested information on utility crossings along the Buffalo River from the mouth of the Buffalo River (approximately at Route 5/Buffalo Skyway) to Seneca Street. Dig Safe NY provided a list of members with possible conflicts in the project area including the following:

- AT&T
- Bell Canada Enterprises Nexxia Corporation
- Buckeye Pipeline Company
- Buffalo Sewer Authority
- City of Buffalo Traffic
- City of Buffalo Fire
- City of Buffalo Water Authority
- Enbridge Energy Partners, Inc
- Erie County Division of Sewer Management,
- Fiber Technologies, LLC
- Level 3 Communications
- Linde LLC
- MCI
- National Fuel Gas
- National Grid
- New York State Thruway Authority
- Sprint Nextel
- Time Warner Cable
- Verizon

Responses were received from most of the members on the Dig Safe NY list by the end of January 2011. Companies who did not respond were contacted by phone for the required information. No response was received from Linde, LLC, Sprint Nextel, and Bell Canada. Responses of no utility crossings in the project area were received from Buckeye Pipeline Company, City of Buffalo Traffic, Erie County Division of Sewer Management, Fiber Technologies, Level 3 Communications, National Fuel Gas, New York State Thruway Authority, and Time Warner Cable. The other utilities supplied maps or descriptions of crossings, and this information was combined with the USACE Buffalo District's Maintenance Dredging Utilities Crossing Map (USACE 2006). The combined list of utilities are mapped in the existing conditions drawings (ED-1 through ED-4 and EH-1 through EH-4) in Appendix B, and the list of utilities are found in the table on Drawing G-2 in Appendix B.

Under a lower-tier subcontract to Affiliated Researchers, which was subcontracted to CH2M HILL, magnetometer survey data were obtained and interpreted by Aqua Survey, Inc., to identify the potential location of buried utilities. Aqua Survey, Inc., detected linear anomalies that were identified as possible crossings along various sections of the Buffalo River (CH2M HILL and Ecology & Environment 2011c). The data were reviewed, and in most cases, the magnetometer data confirmed the presence of reported utilities at or near their reported positions.

Figures 3-64 and 3-65 in Appendix A identify the DMUs and the corresponding anomalies that matched the utilities.

In addition, the survey identified possible crossings that were not reported as utilities by the utility owners that replied to the request. The survey identified crossings in DMU-3, DMU-44e, and DMU-45b that were not identified. Prior to dredging activities, the dredging contractor will be required to perform hard locates for identified utilities located within DMUs.

Project Delivery Strategy

3.1 Preliminary Design

The objectives of the preliminary design were to define in detail the technical parameters upon which the design will be based, develop the conceptual strategies and ideas that compose the framework of the remediation project, review the strategies and concepts with the PCT, and, to the extent possible, finalize the strategies and concepts so the prefinal/final design may proceed with minimal changes and schedule impacts.

The preliminary design package was completed in March 2011.

3.2 Intermediate Design

Once the strategies, concepts, and supporting technical details were developed, reviewed, and finalized in the preliminary design, the intermediate design activities commenced. The strategies and concepts developed during the preliminary design were expanded into a set of intermediate design documents.

The intermediate design package was completed in December 2011.

3.3 Prefinal / Final Design

The developed strategies, concepts, and supporting technical details in the intermediate design were reviewed and incorporated into the prefinal design described in the prefinal BODRs. Complete prefinal design documents consisted of the following:

- Prefinal dredging BODR
- Prefinal habitat restoration BODR
- Specifications
- Dredging and habitat restoration drawings
- Cost estimate
- Revised project delivery strategy
- Site-specific plans
- Biddability, operability, and constructability reviews

The prefinal design was submitted to the PCT for review and comments in December 2012 and January 2013. The final design documents reflect the incorporation of the PCT's comments into the prefinal design.

GLNPO will issue a contract to conduct the remedial action to a dredging contractor based on the final design documents. The dredging contractor will be required to present a detailed work plan to GLNPO and GLNPO's representative describing how the work will be executed. The dredging contractor will be referred to as the contractor in this document. Once the contract is in place, the electronic version of the final drawings, including the final dredge prism, will be issued to the contractor for construction.

Design Approach, Assumptions, and Parameters

Section 4 details the design approaches for mechanical dredging and sediment capping and associated assumptions and parameters. It should be noted that some elements of the design are conceptual with the intent that details will be proposed by the contractor subject to conformance with contractual requirements. A conceptual description of the dredging and capping support, as well as facilities, equipment, and activities is included in this final BODR. Specific requirements associated with the TSCA-level sediment area are presented in Section 4.6. Bidders for the contract will be required to provide a general description of their proposed site layout, dredging equipment, and procedures, so significant proposed modifications can be discussed and evaluated prior to the award of the contract. In addition, before starting the work, the contractor will be required to provide a detailed work plan that will lay out the specifics of the proposed mechanical dredging and capping activities. The work plan will be provided to members of the PCT for review. The contract plans and specifications describe the functional requirements and procedures for these items.

4.1 Minimizing Environmental and Public Impacts

One of the primary objectives of remedy implementation is to minimize adverse environmental and public impacts during dredging and capping operations. Minimizing the impacts is achieved through proper permitting and planning during the design phase, as well as adherence to environmental controls and monitoring during the execution of the project.

4.1.1 Planning and Permitting

The following items related to planning and permitting will be completed:

- TSCA Risk Evaluation Report (prepared by CH2M HILL)
- TSCA Notification and Certification (to be prepared by the USEPA Region 2)
- Technical support and submittals such as work plans, drawings, figures, technical memorandums, etc., for obtaining USEPA Region 2 TSCA approval for dredging of TSCA sediments (to be prepared by the dredging contractor)
- Joint Permit Application that incorporates requirements of Section 10 of the Rivers and Harbor Act of 1899, Section 404 of the Clean Water Act (CWA), and Section 401 of the CWA including an Article 15-Protection of Waters Permit (prepared by CH2M HILL)
- CDF use in accordance with Section 123 of the Rivers and Harbors Act (to be prepared by USEPA GLNPO)
- Preparation of a Full Environmental Assessment Form and an environmental assessment of the dredging project in accordance with 6 New York Codes, Rules and Regulations (NYCRR) part 617 State Environmental Quality Review (SEQR) (prepared by CH2M HILL)
- Determination if an endangered and threatened species review, coastal zone consistency and cultural review are required (performed by CH2M HILL)
- Coordination with the U.S. Coast Guard regarding a Notice to Mariners (to be performed by dredging contractor)
- Preparation of a Stormwater Pollution Prevention Plan in accordance with the State Pollutant Discharge Elimination System (SPDES) General Permit for Construction Activity (to be prepared by dredging contractor)
- Preparation of a Control Program for Temporary Discharge Permit Application to the Buffalo, New York, Sewer Authority Sewer Use Regulation Part 10075 Article VI, Section 14, and in Article 2 Regulations of the Temporary Discharge Permit (to be prepared by dredging contractor)

- Characterization and suitability determination of maintenance dredge material for beneficial reuse for capping or habitat purposes. If material is suitable, additional New York State permits will be required to obtain a beneficial use determination for project use (to be prepared by USACE and NYSDEC).
- A temporary building permit will be required for any support structures. The City of Buffalo will require a survey, a site plan, and a description of the type and configuration of any structures that will be erected as part of the application. The facilities might also require floodplain permits (to be prepared by dredging contractor).

According to USACE, no wetlands were found in the proposed project area (USACE 2010) and hence no wetland permits are needed for this project.

Copies of draft permit applications and draft permits are included in Appendix F.

4.1.2 Execution of Dredging and Capping Activities

Project information will be communicated to local property owners, municipalities, and general members of the public before and during the remedial activities to help limit adverse impacts of the project to residents and commercial activities.

Impacts to water quality from the dredging and capping activities will be minimized by employing BMPs, which are described in Section 4.5.1. River water will be monitored and modifications made to the remedial activities as described in the river water monitoring plan in Appendix H, confirmation sampling of the TSCA DMU, and air monitoring will be conducted as described in the TSCA monitoring plan in Appendix H.

4.2 Site Preparation and Mobilization

4.2.1 Site Preparation and Mobilization Activities

Prior to mobilization to the site, the contractor will verify that the necessary permits have been obtained and the planned remediation will be in compliance with permit requirements. The contractor will submit necessary preconstruction submittals to GLNPO and GLNPO's representative for approval before mobilization. GLNPO will forward relevant submittals to the PCT for concurrent review.

Prior to dredging and capping activities, the contractor will perform site preparation activities at the selected staging area(s). Four possible TSCA staging locations have been identified and pre-screened. The owner of each of the properties has expressed a willingness to enter into an agreement with the dredging contractor to use the property. The following are the four properties:

BIDCO Marine 220 Katherine Street	Contact: Mark Judd Phone: (716) 847-1111
South End Marina 1515 Fuhrmann Boulevard	Contact: William Mackey Phone: (716) 825-0333
Ontario Specialty Contracting Inc. 333 Ganson Street	Contact: John Yensan Phone: (716) 856-3333
Riverbend South Park Avenue	Contact: Peter Cammarata Phone: (716) 362-8361

Locations of the four properties are included in Drawing TS-4 in Appendix B. The four properties were evaluated and the PCT has selected the Riverbend site as the preferred site for the TSCA staging area for this design. If the contractor determines that a different site may be more suitable for their proposed layout and operations for managing the TSCA-level sediments, the contractor will obtain necessary approvals from NYSDEC prior to proceeding.

Mobilization and setup of the handling and processing equipment will likely be performed concurrently with site preparation activities. The site preparation and mobilization activities will include the following:

- Mobilization of equipment and personnel
- If necessary, limited clearing and grubbing of vegetation and implementation of erosion control measures in the areas disturbed at the staging area property
- Establishment of physical construction limits with temporary security fencing around the staging area property
- If desired by the contractor, setup of a site trailer and utility connections
- Construction of staging/stockpile areas, barge docking structure, and drip containment along the shoreline of the staging area property
- Installation of turbidity monitoring equipment in the river by the dredging contractor
- Coordination with owners of marinas and other boat docks and companies receiving regular shipments within the project area to minimize disruption to commerce and recreation
- Notification to U.S. Coast Guard (Notice to Mariners)

4.2.2 Preconstruction Sampling

Preconstruction sampling for the TSCA staging area is described in the TSCA monitoring plan in Appendix H.

4.3 Mechanical Dredging

Parameters such as dredge cut thickness, equipment, and production rates have been provided in this final BODR to develop the schedule and cost estimate for the dredging activities and are not intended to prescribe how the dredging is to be performed by the contractor.

An estimated 462,000 yd³ of non-TSCA material and 4,200 yd³ of TSCA-level sediment are to be removed from the Buffalo River AOC. The estimated average thickness of contaminated material to be removed is approximately 5 feet. The contractor will not be compensated for material dredged beneath the dredge cut line plus an allowable 6 inches of overdredge unless prior approval is received from GLNPO or GLNPO's representative.

For the TSCA area (DMU-8b), the contractor will be required to perform waste characterization sampling as described in the TSCA monitoring plan in Appendix H to allow profiling of the waste for acceptance by the landfill for proper disposal.

4.3.1 Production Rate

Dredging activities are proposed for completion within two dredge seasons, starting in 2013 and being completed in calendar year 2014. The proposed dredging operation would consist of mechanically dredging (462,000 yd³ non-TSCA-level sediment dredging and 4,200 yd³ TSCA-level sediment dredging) using 2 floating mechanical dredge plants with environmental buckets of appropriate size as proposed by the dredging contractor. Hopper barges will be used to transport dredged material. Pushboats/tugs will be used to transfer hopper barges between the dredge area, debris handling area at the CDF, and the CDF offloading area and to move the dredge barges when necessary. The contractor will hydraulically offload the dredged material from the transport barges using water from the CDF to minimize discharge of effluent from the CDF and to aid in meeting the water quality standards outside the CDF. Dredges will operate 24 hours per day and 6 days per week or as otherwise allowed by laws, regulations, or permits or a CWA Section 401 Water Quality Certification. The seventh day of each week will be available for scheduled maintenance or to compensate for unanticipated downtime during the week's activities. During the dredging to design cut lines, each dredge plant is estimated to achieve a maximum production rate between 2,000 and 2,500 in situ yd³ per day, resulting in a projected total maximum dredging production rate of 4,000 to 5,000 yd³ per day. An average production rate of 3,200 yd³ per day is estimated (based on discussions with USACE), which is slightly below the average production rate of 4,000 yd³ per day achieved by USACE during the strategic navigation dredging. During the first two weeks of dredging, a reduced average production rate of 1,300 yd³ per day is estimated while the process is getting started.

USACE prepared an evaluation of dredged material titled “Evaluation of Dissolved Contaminant Releases Resulting from GLLA Dredging in the Buffalo River and Buffalo Ship Canal” (USACE 2011b—also included in Appendix I). The purpose of this evaluation was to predict the maximum allowable sediment loss rates from dredging and maximum allowable production rate with and without resuspension controls. The report recommended operational restrictions in certain DMUs that might reduce the estimated dredge production rate. These restrictions include the following:

- **Production rates**—Concentrations in three DMUs (DMUs 6, 16, and 17) within the Buffalo River AOC require limited production rates designed to keep water quality concentrations in the CDF within acceptable levels.
- **Silt curtains**—Areas that require the use of silt curtains may have lower average production rates due to additional downtime as curtains are rearranged. Eight DMUs (DMUs 6, 8, 9, 10, 16, 17, 37, 41, and 44) require the use of silt curtains.

4.3.2 Dredging Equipment

The federally authorized navigation channel will be used for transporting dredged material during operations; however, dredging activities should not restrict commercial or recreational traffic through the channel. Dredge platforms, material transport barges, tugs, and other support vessels must be capable of navigating the areas. The following dredging equipment will be used:

- **Dredge Platform.** Dredge platforms will be used to complete the dredging. Two dredge platforms will be necessary in order to achieve the desired combined average production rate of 3,200 yd³ per day. Each dredge platform will be equipped with a crane-mounted (or similar) environmental bucket (approximate capacity of 6 yd³ or as otherwise proposed by the dredging contractor), and must have the following capabilities:
 - Provides a level cut during the closing cycle
 - Completely encloses the dredged sediment and water captured
 - Fitted with escape valves or vents that close when the bucket is withdrawn from the water
 - Smooth-cut surface, with no digging teeth
 - Operator controlled using a global positioning system (GPS)
 - Integrated software that allow (1) the bucket position to be monitored in real time, and (2) a horizontal accuracy of 1.0 feet and vertical accuracy of +0 inch to –6 inches
 - Operator control of bucket penetration to avoid overfilling and minimize sediment resuspension
 - Allows the operator to mark the presence of obstructions encountered prior to reaching target dredge elevation

Additional equipment will be available to perform removal of debris or coarse sediment as it is encountered during the dredging activities. Such equipment may include conventional clamshell buckets with teeth or grapples. The dredging contractor will notify GLNPO or GLNPO’s representative when materials need to be dredged with the standard clamshell buckets due to the inability to remove debris with the enclosed environmental bucket.

- **Hopper Barges.** The specific criteria and number of hopper barges required for dredging activities will be determined by the contractor. It is estimated that six hopper barges with a minimum capacity of 600 to 800 yd³ each will be required to conduct the dredging operations efficiently. Appropriate environmental controls similar to those used for the dredge platform also apply to the hopper barges and are specified in Section 35 20 23 of Appendix C, Specifications.
- **Tugs/Pushboats/Support Vessels.** The specific criteria and number of tugs, pushboats, and other support vessels required for dredging activities will be determined by the contractor.

- **Dredge Equipment Mooring Facilities.** Equipment staged on the river must be located in areas that will not impede commercial or recreational boat traffic. The contractor may request permission to install temporary mooring dolphins and/or buoys at the CDF or other locations throughout the river. The locations must be outside the navigation channel and approved by GLNPO (and other regulators as applicable).

4.3.3 Debris Removal

Large debris that cannot be removed with an environmental dredge bucket will be removed using equipment selected by the contractor and subject to approval by GLNPO, such as a standard clamshell bucket with teeth or a grapple. Debris removal can be conducted prior to the start of sediment removal in each DMU or in conjunction with sediment dredging. Debris encountered will be separated from the sediment and disposed of at the CDF. Acceptable debris for disposal at the CDF includes rocks, tree stumps, branches, small steel items, wooden timber, pieces of concrete or other material that is collected as a part of dredging. Items and materials that cannot be disposed of in the CDF include appliances, cars, large concrete pieces greater than 6 feet in any dimension, and hazardous, toxic, or radioactive waste. Such items, if encountered, will be disposed of offsite at a facility permitted to accept such items or materials.

The details of the process will be left to the contractor, but at this time it is anticipated that a dedicated staging pad for debris handling will be established at the CDF (refer to Figures 2A and 2B attached to the *Application for Utilizing the Federal Confined Disposal Facility #4 for Disposal of Dredged Materials from the Buffalo River* in Appendix J). The debris cannot be staged at any other location without a permit from NYSDEC. Hopper barges will move to the CDF debris offloading area for debris removal prior to moving to the offloading area at the CDF, and debris will be loaded into trucks and transported to the appropriate area within the CDF for disposal.

4.3.4 Dredging Sequence

Prior to the start of dredging activities, the contractor will conduct tree trimming, shoreline documentation, and a baseline bathymetric survey. The activities may begin before the dredging start date, and are summarized as follows:

- **Shoreline Survey.** Prior to dredging activities the contractor will document all shoreline areas using photographs and/or video. All photographs or video footage of shoreline areas must be identified on a location map. The documentation will provide the baseline conditions of the shoreline to confirm the shoreline has not been affected by dredging activities. The contractor will provide the documentation to USEPA at least 7 days prior to the commencement of dredging activities.
- **Tree Trimming.** Prior to dredging activities, the contractor must identify shoreline areas where overhanging vegetation will require removal for dredging. All areas identified by the contractor must be approved by GLNPO before vegetation removal can take place. The Buffalo River shoreline has limited areas containing overhanging trees or vegetation, so this is not anticipated to be a significant effort. Limbs removed from overhanging trees will be disposed of at the CDF along with other debris generated during dredging.

The contractor will provide all appropriate equipment necessary to remove identified vegetation. The activities are to be completed prior to the start of dredging activities in each DMU.

- **Pre-dredge Bathymetric Survey.** Prior to the start of dredging operations, a bathymetric survey will be conducted over all areas to be dredged in the City Ship Canal and in the Buffalo River. This will be done to establish the baseline from which pay quantities will be determined when dredging is completed. The contractor will notify USEPA a minimum of 5 calendar days prior to initiating any payment-related bathymetric surveys and accommodate USEPA personnel or USEPA's oversight personnel on the survey vessel.

4.3.5 Dredging Process

Dredging design cut lines were established to go down to glacial till. The glacial till immediately below the soft sediment within the Buffalo River is generally soft and is not expected to be easily discerned from the soft sediment while dredging. In the unlikely event that hard till is encountered above design cut lines and it can be

identified during dredging by the dredge operator, dredging at that location will be considered complete and dredging to the design cut line will not be required. Approval by GLNPO must be given prior to discontinuing dredging before the cut line.

- **General Dredging Schedule.** The Contractor shall submit a DMU dredging schedule to USEPA a minimum of 7 calendar days prior to the commencement of dredging operations. DMU dredging schedule must meet the sequence requirements of Section 4.4 (CDF) and must be approved by USACE and USEPA prior to commencement of dredging activities.
- **General Dredging Operations.** Material dredged from non-TSCA DMUs (all DMUs with the exception of the TSCA-level sediment from DMU-8b) will be placed in material transport barges and transported to the CDF for disposal. The contractor will implement and meet the BMPs for environmental dredging to minimize resuspension during dredging operations during both non-TSCA-level and TSCA-level dredging as presented in Section 30 25 23 of Appendix C, Specifications.

The dredge design cut line as developed from the modeled till surface generally has a gradual slope near the shorelines. The dredge prism is based on a vertical cut to the dredge design cut line at the boundaries of the prism. Sloughing is anticipated and has been accounted for in the volume calculations. The sloughing has been calculated using a 1:1 slope based on information obtained from the USACE strategic and navigational dredging of 2011 and 2012.

Upon the completion of dredging, a bathymetric survey will be conducted to verify the final cut surface is within the specified tolerance and to document post-dredging conditions as a baseline. If the post-dredge survey indicates dredging has not been completed to within these tolerances, additional dredging will be conducted.

- **Sequence of Dredging.** Per requirements for disposal in the CDF, DMUs 8, 9, and 10 will be dredged first, followed by a general upstream to downstream sequence. Some minor variations from this approach will be allowed in order to keep two dredge plants operational.
- **Silt Curtain Requirements.** Silt curtains will be required when dredging the following 9 DMUs: 6, 8, 9, 10, 16, 17, 37, 41, and 44. The following lists requirements for silt curtains:
 - Silt curtains will be established around the dredging operations. The upstream and downstream sides must be installed within 80 meters of dredge platform.
 - Silt curtains must be long enough to cover at least half the depth of the water column.
 - Silt curtains will be at least half the depth of the water column.
 - In no cases will silt curtains be allowed to contact or drag on the bottom.
- **Restricted Production Rates.** Three DMUs will require reduced production rates. The restrictions have been applied to reduce the probability of exceeding water quality standards at the CDF. Dredging operations may take place in only one restricted production DMU at a time. In addition to reducing productivity, each of the DMUs will use silt curtains while dredging as discussed above. Each DMU and the allowed production rates are as follows:
 - DMU 6: DMU 6 is located in the City Ship Canal. It is the most restricted DMU in the Buffalo River AOC. The maximum production rate is 164 yd³ per day (per day in this context refers to a 24-hour period). Silt curtains will be used, and only one dredging platform may be used for up to 3 hours per day.
 - DMU 16: DMU 16 is located in the Buffalo River. The maximum production rate is 595 yd³ per day. Silt curtains will be used, and only one dredge platform may be used for up to 10 hours a day.
 - DMU 17: DMU 17 is located in the Buffalo River. The maximum production rate is 5,038 yd³ per day. Silt curtains will be used. Dredging is allowed 24 hours per day.

Note that because the reason for the restricted dredging rates is water quality at the CDF, the daily quantities represent the maximum volume that can be offloaded at the CDF. Therefore, hopper barges with material from the DMUs should be relocated to other DMUs and filled prior to offloading at the CDF. Staging of one hopper barge at one of the DMUs and filling it completely with material from that DMU before offloading at the CDF would defeat the purpose of limiting dredging rates. The contractor will note approximate quantities from each DMU within each hopper barge offloaded at the CDF in the daily reports. Also, when dredging DMUs 6 and 16, the contractor will provide either bucket counts or completed surveys of the DMUs with the daily reports, which will enable GLNPO or GLNPO's representative to verify that the maximum production rates have been maintained.

- **Utility Crossings.** Dredging will not be conducted within a 3-foot buffer above utilities. A minimum horizontal offset of 25 feet will also be used, consistent with USACE dredging practices in the Buffalo River.
- **Dredging near Critical Structures.** The proposed approach for dredging in the vicinity of critical structures is presented in Appendix K.

4.3.6 Dredging Positioning System

A system that continuously locates and records the horizontal and vertical position of the dredge bucket will be required. A real-time kinematic positioning system, or an alternate positioning system that can meet the specified tolerance requirements, will be used to provide the horizontal and vertical positioning for the dredge system. The positioning system will employ software capable of monitoring the *x*, *y*, and *z* positions of the dredge bucket in real time. The software will be required to provide the following:

- A real-time view of the barge and environmental bucket position
- A display indicating the surface derived from the pre-dredge hydrographic survey data
- A display that provides real-time feedback showing current depth, final project depth, target depth, and current bucket depth

The following tolerances will be met:

- Horizontal position accuracy will be plus or minus 1 foot
- Vertical tolerance will be plus zero, minus 0.5 foot

All the bucket-positioning data collected throughout the project will be maintained and submitted to USEPA by the contractor weekly.

4.4 Confined Disposal Facility

According to USACE's *Environmental Assessment Report* (USACE 2010), USACE's CDF located adjacent to the south entrance channel of the Buffalo Harbor was constructed in 1972. In order to stabilize the perimeter dike, the core was constructed with layers of rock of increasing size. The interior of the perimeter dike of the CDF, constructed of sand and gravel to act as a permeable filter layer, is built up to an elevation of 2.5 feet below mean lake elevation. The stone perimeter with side slopes of 1 horizontal to 5 vertical rises to an elevation of approximately 15 feet above the mean lake level. Water depth around the CDF perimeter is up to 30 feet. A steel sheet pile wall transects the entire length of the stone perimeter dike to a depth of 24 feet. The CDF has 2 weir structures with inverts at an elevation about 10 feet above the mean lake level. The dredged material has typically been placed along the northeast side of the CDF (along the breakwater and land). Once the dredged sediment material is placed in the CDF (below mean lake level) the water from the dredged material seeps out through the filter core at a residence time of approximately 50 days (USACE 2010). The residence period allows suspended solids in water to settle out before moving through the permeable perimeter dike walls. USACE is responsible for structural stability and maintenance of the CDF.

The non-TSCA-level dredged sediments will be directly pumped into the CDF from the material handling barges. Debris that would otherwise clog or damage the pumps used to offload the sediment will be transported to the

staging area property for decontamination. Based on discussions with USACE, the debris can also be disposed of at the CDF.

USACE evaluated the project to determine the need for controls at the CDF (USACE 2011a). The following technical requirements will be necessary for using the CDF (in addition to administrative requirements):

- As part of the operations and dredging plan, the contractor will describe the placement procedure for sediment at the CDF. Depending upon the results of the sediment characterization by the District's Environmental Branch, additional operational requirements may be necessary (USACE 2011a).
- DMUs 8, 9, and 10 should be the first three units dredged to take advantage of the available dilution water in the CDF.

4.5 Water Quality Control Measures During Dredging and Wastewater Generation

4.5.1 River Water

The potential to create turbidity and impact river water quality will be minimized by the contractor's adherence to the following mechanical dredging BMPs:

- Barges will be watertight and inspected to confirm water-tightness prior to dredging operations and dredged material transport.
- Deployment and movement of up- and downgradient turbidity curtains during dredging operation in select DMUs.
- An environmental clamshell bucket (described in Section 4.3.2) will be used for mechanical dredging of sediment.
- Smoothing with the dredging bucket to contour the dredge cut will not be permitted.
- Work on slopes will proceed from top of slope to toe of slope as practicable.
- Use of positioning devices (such as GPS) to allow the operator to be aware of the location of the dredge bucket in relation to the top of the sediment.
- Use of an experienced environmental dredging operator capable of implementing appropriate BMPs to limit resuspension.
- The operator will minimize overfilling of the dredge bucket.
- The operator will adjust the rate of bucket descent and retrieval as necessary to reduce sediment resuspension.
- The operator will perform single bites with the bucket, and each bucket will be brought to the surface and emptied between bites.
- The operator will only decant the environmental bucket by slowly releasing water that drains from the valves in the bucket at the surface.
- The operator will not overfill barges with dredged material, and oil booms will be available for emergency use.

The success of the contractor's efforts to control turbidity will be evaluated through river water monitoring activities as described in Section 6.1. If a turbidity exceedance is noted, the contractor will be consulted and the source of the turbidity will be evaluated. If dredging activities are suspected, the dredging process or equipment will be modified so the turbidity criterion is met.

4.5.2 Wastewater from Stabilization and Decontamination Activities

4.5.2.1 Non-TSCA-level Sediment Dredging

The only source of wastewater during dredging of non-TSCA-level sediment will be decontamination activities. Decontamination of equipment and debris will likely occur on the asphalt pad at the staging area property (if desired by the contractor), and will generate a relatively small quantity of wastewater. Precipitation will generate a minimal amount of wastewater during non-TSCA-level sediment dredging; only the precipitation falling on the asphalt pad during active decontamination activities will require storage and disposal. An estimated 400 gallons of water per day will be used in the decontamination process. Potable water will be used for decontamination.

Non-TSCA wastewater generated from the decontamination activities during dredging of non-TSCA-level sediment will be stored in tanks on the asphalt pad and either be transported to the CDF and used to lower the solids content of the non-TSCA-level sediment being pumped from the material handling barges or will be disposed of offsite at an appropriate facility.

4.5.2.2 Capping

No wastewater generation is anticipated during sediment capping activities.

4.6 TSCA Material Handling and Disposal

Section 4.6 details the design approaches for mechanical dredging in DMU-8b for TSCA-regulated PCB-contaminated sediments. It should be noted that elements of the design are conceptual with the intent that details will be proposed by the contractor for this activity, subject to compliance with relevant permits and approved by the appropriate agencies. A general conceptual description of the dredging support, as well as facilities, equipment, and activities on the Riverbend property is included in this final BODR. Bidders for the specific work will be required to provide a description of their proposed site layout, dredging equipment, and procedures, so any significant proposed modifications can be evaluated prior to the award of the contract. In addition, before starting the work, the contractor will be required to provide a detailed work plan that will lay out the specifics of the proposed mechanical dredging, contact water processing, TSCA material handling and staging, appropriate licenses and registrations, and regulated transport and disposal of all waste streams associated with the DMU-8b activities. The site-specific work plan for the DMU-8b activities will be provided to members of the PCT for review. The contractor will also work with USEPA and PCT to provide information and submittals to NYSDEC and USEPA Region 2 required for approval of the contractor's proposed work plan for TSCA dredging.

4.6.1 Execution of TSCA Dredging Activities

Impacts to water quality from the TSCA dredging activities will be limited by employing BMPs, which are described in Section 4.5.1. River water will be continuously monitored for turbidity, and exceedances will be communicated so modifications to the operations, process, or equipment can be made. Water quality monitoring, confirmation sampling, and air monitoring will be conducted as described in the plans in Appendix H.

4.6.2 Site Preparation and Mobilization Activities

Prior to mobilization for the TSCA work in DMU-8b, the contractor will verify the necessary permits have been obtained and the planned remediation is in compliance with permit requirements. The contractor will deliver necessary preconstruction submittals to GLNPO and GLNPO's representative for approval before mobilization.

The TSCA material staging area will be selected by the contractor following award of the dredging contract based upon discussions with property owners. If a site other than the Riverbend property is selected, the contractor will coordinate with NYSDEC to revise or obtain the necessary permits. The size requirement for the staging/processing area is approximately 1 acre. Regardless of the area selected, a USEPA ID number must be obtained to allow manifesting the sediments and debris for offsite disposal. Currently, no USEPA ID number is available for the TSCA wastes.

Mobilization and setup of the handling and processing equipment will likely be performed concurrently with site preparation activities. The site preparation and mobilization activities specific to the TSCA material management will include the following:

- Mobilization of equipment and personnel
- If necessary, limited clearing and grubbing of vegetation and implementation of erosion control measures in the areas disturbed at the staging/processing area property
- Establishment of physical construction limits with temporary security fencing around the staging area property
- Setup of a site trailer and utility connections
- Personnel, equipment, and transport decontamination stations for handling and processing sediments, debris, and contact water liquids
- Construction of a staging/stockpile areas, barge docking structure, and drip containment along the shoreline of the staging area property (specifically for offloading of TSCA-level sediments and debris)
- Construction of an asphalt pad, haul roads, water treatment system, and other temporary infrastructure at the staging area

4.6.3 Preconstruction Sampling

Once the layout of the staging area has been approved by GLNPO, samples will be collected from the offsite staging/processing area property for analysis as described in the TSCA monitoring plan in Appendix H. The purpose for collecting the samples is to document preconstruction conditions for comparison to samples collected after remedial activities have been completed.

After site demobilization, post-construction samples will be collected and analyzed as described in the TSCA monitoring plan in Appendix H.

4.6.4 Asphalt Pad and Site Access Roadways

The mechanical dredging of TSCA-level sediments will require construction of temporary access roads and a staging area if such infrastructure is not already present at the offsite property. A high-density polyethylene lined area will be used for the reagent storage area, sediment and debris stockpile/processing areas, temporary onsite contact water processing treatment plant area, and decontamination area for trucks hauling stabilized sediments and debris offsite.

The TSCA-level sediment and debris stockpile areas will be constructed with a perimeter berm and will be sloped to collect contaminated water. The construction will include preparation of the existing surface, berming and sloping the processing area with structural fill, installation of a high-density polyethylene geomembrane liner, and creation of low-point sumps and piping to facilitate collection and pumping of the wastewater. The SPDES stormwater program requires a 25-year, 24-hour rainfall event to be used to size the treatment plants for each sediment processing area. In addition to the SPDES stormwater program, a 25-year, 24-hour design storm event is required to be considered by TSCA (40 *Code of Federal Regulations* [CFR] 761.61 and 40 CFR 761.65). The regulations implement TSCA requirements for liners, covers, run-on control, and collection and treatment of water. The precipitation depth for a 25-year, 24-hour storm event for the Erie County area is 4 inches (Northeast Regional Climate Center, Cornell University).

While it will be unlikely that dredging and sediment processing activities will be occurring during such large precipitation events, the pad, berm, and temporary wastewater treatment plant will be sized to receive the estimated stormwater flow rates during the entire project.

Once activities requiring use of the asphalt pad are completed, the contractor will dispose of the asphalt pad materials at a permitted landfill. The impervious surface of the site access roadways or asphalt pad will be washed off and will be tested for total PCBs by the Contractor. If results are below the standard of 1 mg/kg total PCBs as

described in 40 CFR 761, it will be broken up, removed, and either reused or disposed of offsite at a nearby RCRA Subtitle D landfill.

The base material for the site access roads or asphalt pad, as well as the materials comprising the temporary site access roads, will be tested for total PCBs by the Contractor, and will be allowed for reuse if results are below the standard of 1 mg/kg total PCBs as described in 40 CFR 761.

4.6.5 Mechanical Dredging—TSCA Materials

An estimated 4,200 yd³ of TSCA-level sediments and 1,400 yd³ of non-TSCA-contaminated sediments are expected to be mechanically dredged from DMU-8b as shown in the drawings in Appendix B. Non-TSCA material overlays the TSCA material and varies in thickness between 2 and 3 feet. The limits of the non-TSCA dredging are shown on the DMU-8b drawings cross section views (Appendix B). TSCA-contaminated sediments within DMU-8b extend down to the top of glacial till at an elevation of 540 feet.

TSCA materials will be characterized for disposal and post-dredging confirmation samples will be collected as described in the TSCA Monitoring Plan in Appendix H.

The performance standards for the mechanical dredging in DMU-8b consist of the following:

- Removal of non-TSCA-level sediments to specified elevations
- Removal of TSCA-level sediments to the specified elevations
- Minimization of sediment resuspension to below the turbidity, total suspended solids, or other water quality monitoring standards as established by the PCT

The contractor will perform both a pre-dredging hydrographic survey and a post-dredging hydrographic survey after removing the non-TSCA-level sediment. A post-dredging survey will also be performed after completion of the TSCA-level sediment removal. The surveys will be used to provide the final dredged sediment volumes for payment.

The cut lines for the non-TSCA-level sediment overlying TSCA-level sediment have been established 1 foot above the boundary between the materials to allow the contractor one foot of buffer before removing TSCA-level sediment. The contractor will be directed to dredge \pm 6 inches from the cut line.

When dredging the TSCA-level sediment, the contractor will not be compensated for material dredged beneath the dredge neat line elevation with a 6-inch overdredge allowance unless prior approval is received from GLNPO.

4.6.6 Dredging Equipment

Mechanical dredging of contaminated sediments will be performed by one of the mechanical dredge plants mobilized for the project. The dredging of DMU-8b (estimated total of 5,600 yd³) sediment is expected to be accomplished in approximately 10 working days following waste characterization profile acceptance. The dredge plant will be decontaminated prior to use on the non-TSCA portion of the project.

4.6.7 Offloading, Stabilization, Handling, and Disposal

Sediments with TSCA-level concentrations will be mechanically dredged and loaded into the watertight barges and transported to the dock area for offloading to the pad on the staging area property. Free water on top of the sediment will be pumped directly from the barge to a temporary onsite water treatment system. An excavator or similar equipment will be used to remove TSCA-level sediment from the barge and stockpile it on the pad.

Large debris present in the TSCA material will be handled as described in the TSCA monitoring plan in Appendix H. A drip containment pad with a sloped, non-porous surface will be used in between the barge and the offloading pad to contain any material that might fall out of the excavator bucket during offloading. Any such material will be disposed of along with stockpiled TSCA-level sediments. The drip containment pad material can be of metal, concrete slab, or as proposed by the contractor and accepted by GLNPO.

Stockpiled TSCA-level sediments will be stabilized with either Type III Portland cement or another suitable stabilization reagent as proposed by the contractor based on stabilization testing studies. The sediment will be

cured until it is dry enough to pass a paint filter test and meet other specifications required by the landfill. The contractor will develop a specific material stabilization approach and will conduct the stabilization testing studies for the Buffalo River sediments. Stabilized sediment will then be directly loaded into a fully lined truck trailer staged on the asphalt pad. Once trucks are loaded, they will be moved to the decontamination area and covered with a tarp. The exterior of the trucks will be decontaminated with a pressure washer to remove visible sediment and soil. Upon completion, a visual inspection will be performed to verify that no residual sediments and soils are on the vehicle prior to transport over the public highway. After completion of the decontamination process, the truck will depart the site and transport the sediment to a TSCA-permitted offsite landfill.

A uniform hazardous waste manifest will be used to transport the TSCA wastes for disposal at an approved facility. In New York State all TSCA wastes are RCRA listed hazardous waste. The RCRA waste code for soils, solids, and dredge materials with total PCB concentrations over 50 mg/kg, is B007.

Water released from stockpiled materials, generated during decontamination activities, or falling on the pad as precipitation will drain to a sump on the pad and will be pumped to the temporary onsite water treatment unit. Suspended solids and adsorbed contaminants in the water will be removed by the water treatment/processing system, which, conceptually, will consist of a mixing tank, inclined plate clarifier, sand filtration, and granular activated carbon (GAC) filtration (see Section 4.6.9).

An estimated schedule for dredging and processing TSCA- and non-TSCA-level sediments from DMU-8b is provided as part of the overall project schedule in Appendix E.

4.6.8 Equipment and Support Materials Decontamination

All equipment and support materials used for TSCA material processing and handling will undergo decontamination following completion of TSCA material removal. Decontamination procedures are described in the TSCA monitoring plan in Appendix H.

4.6.9 Wastewater Treatment

Wastewater will be generated from the following sources during the handling, stabilization, and disposal of TSCA-level sediment:

- Free water from sediment that is pumped out of the hopper barge
- Decontamination water
- Precipitation on the processing pad and contacting stockpiled TSCA-level sediments
- Backwash wastewater from the onsite water treatment system

A temporary wastewater treatment system will be mobilized to the staging area property by the contractor to treat generated wastewater. After initial treatment, the water will be collected into frac tanks for permit compliance analytical testing. If the treated waters meet the discharge limitations, they will be discharged either to the sanitary sewer of the Buffalo Sewer Authority under a temporary discharge permit or discharged to the Buffalo River under a New York SPDES permit. If the analytical results are above the discharge criteria, the waters will be reprocessed until the permit compliance limits are achieved by the prescribed agencies.

The following paragraphs summarize a conceptual design for the temporary onsite water treatment system. The contractor is allowed to propose an alternative water treatment system design. The contractor will meet the performance standards as defined by the temporary discharge permit.

Wastewater sources will be combined in a mixing tank, chemically conditioned, and flow by gravity into an inclined plate clarifier. The supernatant from the clarifier will be pumped to one or more sand filters, and then into a series of GAC filters. The GAC vessels will be selected based on hydraulic capacity and will be operated in a lead-lag mode (series flow). GAC and sand filter backwash wastewater will be sent back to the mixing tank. The GAC effluent will be stored in one of three holding/storage tanks.

Monitoring of the water treatment system is described in the TSCA monitoring plan in Appendix H.

Once monitoring requirements have been met, the water will be discharged to the sanitary sewer at a manhole located on the staging area property. Coordination of the discharge location will be performed with the property owner. If applicable, the Buffalo Sewage Authority will be asked to verify there is sufficient capacity in the sewer system to handle flow generated by the remedial activities. Alternatively, the contractor might choose to treat the wastewater such that it can be discharged back to the Buffalo River. In this case, the contractor will be responsible for obtaining the appropriate SPDES permit(s).

A portion of the effluent from the GAC vessels may be stored as a non-potable water source for treatment plant use and backwash cycles. Potable water will be used as a backup water supply.

The treatment system controls and monitoring devices, at a minimum, will include the following:

- Flowmeters to indicate influent flow to the treatment system, key unit processes, and final effluent
- Turbidity meters to monitor water quality of effluent from the GAC filters
- Variable speed pumps to regulate the flow rate through the treatment system
- Pressure gauges to monitor headloss across the GACs
- Sampling ports to enable collection of samples of system influent and effluent

Once the TSCA-level sediments have been disposed of offsite, the temporary water treatment system will be decontaminated and demobilized. Media used in water treatment will be sampled, characterized, and disposed offsite at an approved facility.

4.7 Armor Capping

As discussed in Section 1, capping is part of the selected remedial alternative for the Buffalo River AOC. The project includes an armored cap designed for the physical and chemical conditions at select locations, including DMU 1, DMU 2, and other areas as shown in the drawings (Appendix B). The armor cap design was performed by following the procedures described by the USACE Waterway Experiment Station, USEPA guidance document (Palermo et al. 1998), analytical steady-state model version 1.13 (Lampert and Reible 2008), and the Federal Highway Administration. The stone size necessary to resist erosion during a 100-year flood event was calculated using Maynard's Equation from EM 1110-2-1601 (USACE 1994) and compared with the stone size necessary to resist erosion resulting from propeller wash based on Appendix A of the USEPA/USACE Cap Design Guidance (Palermo et al. 1998). The larger stone size was then chosen as the recommended stone size for design purposes. Armor layer thickness estimation, gradation, and filter layer design is based on Federal Highway Administration HEC-11 (USDOT 1989). Appendix D describes the cap design objectives, design considerations, capping material selection process, potential capping material sources, cap configuration, and cap placement methods.

Based on the design calculations, it was determined that the armored cap will contain three layers—one armor stone layer with a minimum thickness of 8 inches and two filter layers, each with a minimum thickness of 4 inches. Drawing DO-1 and DD-2 show the plan view and the cross-sectional views of the armored cap within DMU 1 and DMU 2.

The cap to be placed at the head of the City Ship Canal is described within the Final Basis of Design Report for Habitat Restoration (CH2M HILL 2013).

4.8 Working Season and Hours of Operation

It is anticipated that most activities associated with the mechanical dredging work will be performed 24 hours a day, 6 days a week. The seventh day will be reserved for maintenance work or to compensate the downtime incurred during the work week.

Mobilization is anticipated to start in 2013 (refer to the preliminary construction schedule in Appendix E). The permissible environmental windows for water and dredging activities are June 15 through December 30 for the Buffalo River and July 1 through December 30 for the City Ship Canal. In addition, the placement of material in the CDF during the month of June is restricted to avoid any disturbances to the bird (gulls) nesting activities. Dredging

activities are assumed to end at the end of November due to weather conditions. It is expected to take two construction seasons to dredge the 462,000 yd³ of contaminated sediments and perform capping activities.

4.9 Decontamination

After mechanical dredging activities have been completed, decontamination activities will be performed. Sediment adhered to equipment—including the environmental bucket, hopper barges and front-end loader—will be washed off. Following equipment decontamination, the asphalt pad will be washed off. Residual rinse water will be pumped to the wastewater storage tank and taken offsite for disposal.

Once decontamination has been completed, the temporary infrastructure built for the mechanical dredging work will be removed from the staging area property. Tanks and other equipment will be decommissioned and taken offsite. The asphalt pad will be removed and disposed of offsite at an RCRA Subtitle D landfill. Other materials will be disposed at an RCRA Subtitle D landfill or sampled to verify they have not been contaminated during remedial activities and then taken offsite for potential reuse. The contractor will be responsible for preparation of a decontamination plan for equipment and materials associated with the TSCA dredging effort and for coordinating with USEPA in order to obtain final approval from the Region 2 TSCA program of the contractor's decontamination and disposal plan.

Sampling and disposal of decontamination water is described in the TSCA monitoring plan in Appendix H.

Compliance with Applicable Requirements

The following sections provide a list of applicable requirements for different activities that are part of the Buffalo River AOC remedial action, including dredging and placement of backfill and/or cap materials. The following sections identify and summarize the relevant federal and state environmental permitting laws and regulations, as well as establish how the remedial design and/or remedial action will satisfy the requirements of these laws and regulations.

5.1 Toxic Substances Control Act

TSCA regulates the remediation of river sediment under either 40 CFR 761.61(b), Performance-based Disposal, or 761.61(c), Risk-based Disposal. Based on GLNPO's coordination with USEPA Region 2, the dredging of less than 50 ppm sediments will be regulated under 40 CFR 761.61(b) and the armored capping of greater than 1 ppm PCB material and the dredging of greater than 50 ppm PCB sediments will be regulated under 40 CFR 761.61(c). USEPA GLNPO has already completed the coordination and notifications with the Region 2 TSCA program that are necessary for implementation of the 40 CFR 761.61(b) portions of the work (that is, the less than 50 ppm dredging). However, the contractor will be responsible for coordinating with GLNPO and USEPA Region 2 regarding details of the proposed implementation approach, sampling, and decontamination plans in order to obtain final regulatory approval from USEPA Region 2 for the 40 CFR 761.61(c) portions of the work. The watertight scow barges, barge mooring facility, offloading apparatus, sediment processing area, and operational procedures will be designed and operated to address the requirements in the regulations, or as accepted under the Risk-based Disposal Approval.

TSCA also requires soil and sediments contaminated with PCBs at concentrations of 50 mg/kg or greater be disposed of at either a hazardous waste landfill permitted under RCRA or at a chemical waste landfill permitted under TSCA. New York has delegated authority for implementing RCRA and soils, sediments, oils and other materials containing PCBs at concentrations of 50 mg/kg or more are considered listed hazardous waste with waste codes B001 through B007. Through sediment sampling conducted prior to the development of this report, PCB contaminated sediments from specific locations within the Buffalo River AOC have been identified as meeting the TSCA disposal criteria and as being RCRA hazardous with waste code B007. The applicability of New York State RCRA regulations has been discussed with NYSDEC who indicated that the project can proceed without their issuance of a RCRA permit. However, the regulations were considered in the design of the TSCA remediation and will apply to the transportation and final treatment/disposal of the TSCA material.

TSCA and New York State regulations also state soil contaminated with PCBs at concentrations of 50 mg/kg or greater in bulk may be stored onsite for up to 180 days [40 CFR 761.65 (c)(9)], provided controls are in place for prevention of dispersal by wind or generation of leachate. It is expected that the temporary stockpiling and stabilization of sediments contaminated with PCBs at concentrations of 50 mg/kg or greater will occur on the staging pad at the staging area property prior to offsite shipment of the sediments to a TSCA-permitted disposal facility. Therefore, substantive compliance with 40 CFR 761.65 and 6 NYCRR Part 370-376 will be attained through designing the staging pad such that the requirements of 40 CFR 761.65 and applicable parts of 6 NYCRR are met, specifically, New York State Part 371—Identification and Listing of Hazardous Wastes, Part 372—Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities, and Part 373-1—Hazardous Waste Treatment, Storage, and Disposal Facility Permitting Requirements.

Sediments from DMU-8b will be staged and stockpiled to allow further release of pore water. Pore water from the hopper barges would be collected and pumped to the water treatment plant. Residual sediments from the hopper barges would be pumped or transferred staging and stockpile area for additional processing. Pore water will be collected and pumped to the water treatment facility for processing per Section 4.6.9.

The dredged sediments will be stabilized with an approved stabilizing agent to be structurally stable for shipment to the disposal facility. For quality assurance requirements of the disposal facility, slump cone tests, paint filter

tests, and batch analytical testing (typically every 500 yd³) will be performed to conform to the facility's permit requirements.

5.2 Clean Air Act

The Clean Air Act (CAA), 40 CFR, Parts 50 through 99, is intended to protect the quality of air and promote public health. Title I of the Act directs USEPA to publish national ambient air quality standards for "criteria pollutants." The National Ambient Air Quality Standards, Section 109 provides specific requirements for air emissions including, but not limited to, particulates, volatile organic compounds, and hazardous air pollutants. USEPA also has provided national emission standards for hazardous air pollutants under Title III of the CAA. Hazardous air pollutants are designated hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act. The CAA amendments of 1990 greatly expanded the national emission standards for hazardous air pollutants by designating 179 new hazardous air pollutants and directing USEPA to attain maximum achievable control technology standards for emission sources. Such emission standards are potential requirements for remedial actions producing air emissions or regulated hazardous air pollutants.

No state or federal air permit is required for these activities. Significant amounts of airborne particulates are not likely to be generated, but stabilization activities for the TSCA-level sediment may cause some airborne particulates. Therefore, best available practices will be used, as necessary, to control potential particulate emissions.

Air monitoring will be implemented in accordance with NYSDEC Technical Guidance for Site Investigation and Remediation, DER-10 Appendix 1A, New York State Department of Health Generic Community Air Monitoring Program (NYSDEC 2010). Air monitoring is described in the TSCA monitoring plan in Appendix H.

5.3 Clean Water Act

The CWA, 33 United States Code (USC) §1251 to 1376 and 33 CFR, Part 323, provides regulations for the discharge of pollutants into the waters of the United States. It requires USEPA to set water quality standards for all contaminants in surface waters, and requires permits be obtained for discharging pollutants from a point source into navigable waters such as the Buffalo River. The CWA also regulates dredged and fill discharges. Although actual discharge of the dredged material back into the river is not anticipated, excavation within the river constitutes discharge of dredged material. Also, the CWA is triggered by activities such as dredging, capping, and filling for restoration which are part of this remedial action.

Regulations promulgated under the authority of the CWA require permits for dredging or excavating sediments in navigable water. The applicable permits include the Section 404 permit, authorized by USACE, and the Section 401 Water Quality Certification issued by NYSDEC. A Section 401 certification is necessary for all projects requiring a Section 404 permit and is part of the Section 404 permit review process. Because the Buffalo River is designated as a navigable waterway, the requirements and conditions of the Section 404 permit and Section 401 certification will be met. Typical requirements include actions to minimize resuspension of sediments and control erosion during dredging operations. The New York State Division of Water Technical and Operational Guidance Series (5.1.9), In-water and Riparian Management of Sediment and Dredged Material was considered in the project design. Unavoidable impacts during dredging must be minimized, and impacts that cannot be minimized must be mitigated. Attainment of both the Section 404 permit and the Section 401 certification will be completed through submission of NYSDEC's Joint Permit Application Form. The process also will include attaining an Article 15—Protection of Waters Permit. According to USACE, no wetlands exist in the project area; therefore, no wetlands permit is required. The CWA is also met through the Buffalo Sewage Authority's discharge permit. If the treated water is discharged to the Buffalo Sewage Authority, this project will meet Buffalo Sewage Authority's pretreatment requirements for discharge to their sewer and treatment system.

5.4 Federal Water Pollution Control Act and State Pollutant Discharge Elimination System

Section 402 of the Federal Water Pollution Control Act, 33 USC §1342, allows USEPA to authorize NYSDEC to issue permits and establish requirements for point source discharges from facilities or activities that will generate wastewater or stormwater. Through Section 402, NYSDEC regulates such discharges through the SPDES NYCRR Subpart 750. The SPDES program regulates discharges to both groundwater and surface waters. Additionally, SPDES permits for discharges are required to include effluent limits and conditions while also taking into account available technology for the treatment of such wastewater/stormwater and applicable water quality standards.

The discharge from the temporary wastewater treatment plant associated with the TSCA material staging area is anticipated to be done in accordance with a Buffalo Sewer Authority permit (see Section 4.1.1). A state SPDES permit will only be required if the contractor elects to discharge treated water directly to the Buffalo River.

While the sediment removal activities are not expected to qualify as a point source for direct discharges of wastewater/stormwater per Federal Water Pollution Control Act and SPDES regulations, upland disturbances of at least 1 acre for habitat reconstruction activities are anticipated. Therefore, the requirements for an SPDES General Permit (GP-02-01) for construction activities will be met, including the development of a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP will be prepared in accordance with the technical standards within NYSDEC's New York Standards and Specification for Erosion and Sediment Control, which mandates the required contents of the SWPPP and sampling/inspection of any stormwater controls at a construction site.

5.5 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899, 33 USC §401 et seq. and 33 CFR, Parts 403 and 322, prohibits excavation or fill within the limits of the navigable waters of the United States. USACE has dredged the navigational channel previously and the dredging performed during this project will be adjacent to the navigational channel.

The work is being coordinated with USACE for project requirements and notifications for work that could affect the navigational channel. USACE has authority under Section 10 to grant a Nationwide Permit 38, which will be applied for under New York's Joint Permit Application Form, including typical requirements to be met for dredging and backfilling/capping within a navigable waterway, such as measures to minimize re-suspension of sediments and erosion of sediments and stream banks during excavation. The work conducted under the remedial action will be designed and performed in a manner that meets the requirements of Section 10 of the River and Harbors Act.

5.6 Endangered Species Act

The Endangered Species Act of 1973, 16 USC §1531 et seq. and 15 CFR, Part 930, requires federal agencies ensure any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat. Correspondence from the New York State NHP identified 15 rare species that are known to currently persist in the project area, five of which are listed as threatened or endangered (see Table 4). None of the species is federally listed.

TABLE 4
Natural Heritage Report on Rare Species

Common Name	Scientific Name	New York State Legal Status	Area
Birds			
Peregrine falcon	<i>Falco peregrines</i>	Endangered	Project vicinity
Least bittern	<i>Ixobrychus exilis</i>	Threatened	Project vicinity
Pied-billed grebe	<i>Podilymbus podiceps</i>	Threatened	Project vicinity

TABLE 4

Natural Heritage Report on Rare Species

Common Name	Scientific Name	New York State Legal Status	Area
Common tern	<i>Sterna hirundo</i>	Threatened	Project vicinity
Fish			
Black redhorse	<i>Moxostoma duquesnei</i>	Special Concern	Buffalo River
Freshwater Mussels			
Fragile papershell	<i>Leptodea fragilis</i>	Unlisted	Buffalo River
Pink heelsplitter	<i>Potamilus alatus</i>	Unlisted	Buffalo River

Based on the location of dredging activities that will be conducted within the Buffalo River, it is not anticipated the critical habitats will be affected. To comply with the requirements, USEPA will consult with NYSDEC to obtain concurrence that no critical habitat will be adversely affected during implementation of the dredging operations.

Additionally, USFWS will be consulted regarding federally protected threatened and endangered species in the project area, including verifying compliance with the Bald and Golden Eagle Protection Act.

5.7 National Historic Preservation Act

The National Historic Preservation Act, 16 USC §661 et seq. and 36 CFR, Part 65, establishes procedures for preserving scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. Within New York State, National Historic Preservation Act requirements, as well as those authorized under the New York State Historic Preservation Act of 1980, are administered by the State Historic Preservation Office (SHPO). SHPO has been contacted to determine the potential for the remedial action to disturb or impact any significant archaeological resource. The results of the cultural and archaeological resource assessment will be presented as part of the SEQR review discussed in the following subsection.

5.8 State Environmental Quality Review

In New York State, most projects or activities proposed by a state agency or unit of local government, and all discretionary approvals (permits) from a New York State agency or unit of local government, require an environmental impact assessment as prescribed by 6 NYCRR Part 617 SEQR. SEQR requires the sponsoring or approving governmental body to identify and mitigate the significant environmental impacts of the activity it is proposing or permitting to land, air, plants and animals, water quality, historic or archeological resources, and the potential for the project to create noise and odor impacts.

The Buffalo River dredging project will require permits from New York State and is subject to SEQR. The process was initiated after the intermediate design was complete. The SEQR submittal included a Long Environmental Assessment Form with an attached Environmental Assessment that describes the impacts of the dredging project. The SEQR process also included consultation with USFWS, New York State Fish and Wildlife Service, and SHPO. NYSDEC received the SEQR and will coordinate the review with the City of Buffalo and other interested agencies.

5.9 Beneficial Reuse Materials

Beneficial reuse material as identified by USACE may be used as a cap material for the project area or as backfill for habitat restoration. The potential source areas for this material are located in the upstream section of the Buffalo River. USACE and NYSDEC are discussing the use of such material and the required chemical testing for characterization purposes. Sediments samples were obtained for chemical characterization in fall 2011, and

further bioaccumulation and toxicity testing was performed in the winter of 2011/2012. A report is forthcoming, at which point the potential for use of the material can be determined, and if feasible, a permit for using beneficial reuse material will be obtained.

5.10 Occupational Safety and Health Administration Requirements

A health and safety plan for construction and remedial activities in accordance with the Occupational Safety and Health Administration requirements listed in 20 CFR 1910 and 20 CFR 1926 will be required prior to undertaking any remedial action.

5.11 Local Notice to Mariners

The U.S. Coast Guard publishes a Local Notice to Mariners as a means of distributing information regarding impacts or disturbances to navigable waters, including: impacts to aids to navigation, hazards to navigation, and other items of interest. Due to the proximity of the remedial action to the navigation channel within the Buffalo River, a Local Notice to Mariners will be issued through the U. S. Coast Guard's Navigation Center once the dredging schedule is known more precisely. GLNPO's representative will coordinate with the U. S. Coast Guard's Navigation Center once the dredging contract is awarded. In-water equipment will be demarcated using standard Coast Guard markings.

5.12 Building Permit

A temporary building permit will be required for any project support structures. The City of Buffalo will require a survey, a site plan, and a description of the type and configuration of any structures that will be erected as part of the application.

Performance Monitoring and Operations and Maintenance Requirements

6.1 Water Quality Monitoring

Monitoring of river water is presented in the river water monitoring plan in Appendix H. Water treatment system effluent sampling and analysis is described in the TSCA monitoring plan in Appendix H.

6.2 Sediment Confirmation Sampling and Residuals Management

The TSCA monitoring plan in Appendix H describes a post-dredging confirmation sampling approach for DMU-8b with TSCA-level sediment. Confirmation sampling after removal of non-TSCA-level sediment will not be performed, since the goal is to dredge to the estimated top of till elevation with an over-dredge allowance of 6 inches. Therefore, no contaminated sediment is expected to be present for sampling and a post-dredge bathymetric survey will be used to verify the completion of dredging.

Post-construction sampling will be performed at Year 2 and Year 5 following dredging as described in the residuals management plan in Appendix H.

6.3 Air Monitoring

Air monitoring will be conducted as described in the TSCA monitoring plan in Appendix H.

SECTION 7

Construction Schedule

A construction schedule for the mechanical dredging and capping is provided in Appendix E.

SECTION 8

Biddability and Constructability Review

The project review team, including staff from CH2M HILL's affiliate, CH2M HILL Constructors, Inc., has reviewed this final BODR, and comments were incorporated, as appropriate. The review by CH2M HILL Constructors, Inc., emphasized biddability and constructability.

SECTION 9

Specifications

Complete specifications conforming to the Construction Specifications Institute format are provided with this final BODR in Appendix C.

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TABLE 1

Beneficial Use Impairments Addressed by the Selected Remedy

Beneficial Use Impairments	Selected Remedy	Impact on BUIs
Restrictions on fish and wildlife consumption Tainting of fish and wildlife flavor Degradation of fish and wildlife populations	Capping and Mechanical Dredging	Capping and removing the contaminated sediments from the AOC will result in a cleaner, less-toxic environment and contaminant-free food for the fish and wildlife. This in turn removes the restrictions on its consumption and improves the health and flavor of the fish and wildlife. The removal of the contaminated sediments also results in improved life conditions for the habitat.
Fish tumors and other deformities Bird or animal deformities or reproductive problems	Capping and Mechanical Dredging	By capping and removing the sediments contaminated with known carcinogens such as PCBs and PAHs, the fish and wildlife can be free from the potential tumor and deformity-causing agents. Bioaccumulation of PCBs and PAHs in the higher organisms also reduces with the cleaner/less toxic fish and wildlife.
Degradation of benthos	Mechanical Dredging	The removal of the contaminated and degraded sediment bottom will result in a fresher and less contaminated layer for the benthic organisms. This in turn offers a less contaminated food source to the fish and wildlife.
Restrictions on dredging activities	Capping and Mechanical Dredging	Removal of contaminated sediments will permit disposal of dredged materials at the CDF without restrictions during future navigational dredging activities.
Degradation of aesthetics Loss of fish and wildlife habitat	Habitat Restoration	The clean sediments (after dredging and capping) will provide an appropriate substrate for the habitat restoration activities. Restoring the natural aquatic habitat and wildlife in the AOC will improve the aesthetics and help fish and wildlife thrive.

Table 2. Final Design Volume Estimates by Dredge Management Unit (DMU)

last update: 2/25/2013

DMU No.	Dredge Area Name	USACE Dredge Depth	EPA Dredge Depth	DMU Total Dredge Volume	USACE Dredge Volume (cy)	Total EPA Dredge Volume (cy)	Potential Undredged Volume (total DMU) (cy)	Potential Dredged Volume (cy)	DMU Dredge Surface Area (ft ²)	Average Dredge Depth (ft)	Allowable Over-dredge Volume (cy)	Operational Dredge Volume (cy)
Buffalo Ship Canal												
1	DA-1	545.7	to till on noncritical structure side of the river	9,800	1,600	8,200	5,500	2,700	44,800	2.1	800	3,500
2		545.7	only and to 5 ft of noncritical structure	8,000	1,500	6,500	5,100	1,400	38,800	1.5	700	2,100
3	DA-2	545.7	to till	6,600	1,700	4,900	0	4,900	75,600	2.3	1,400	6,300
4a		545.7		8,100	2,500	5,600	0	5,600	82,400	2.3	1,500	7,100
4b	R-01	545.7	No environmental dredging									
5	DA-03	545.7	to till on noncritical structure side of the river	12,400	2,700	9,700	4,400	5,300	52,900	3.2	1,000	6,300
6a	R-02	545.7	only	8,800	1,300	7,500	3,700	3,800	24,600	4.7	500	4,300
6b	DA-04	545.7	to till, to riprap	10,000	1,000	9,000	200	8,800	48,800	5.4	900	9,700
7a		545.7		7,000	600	6,400	200	6,200	40,900	4.6	800	7,000
7b	R-03	545.7	No environmental dredging									
Buffalo River												
8a	DA-17	545.7	to till	3,700	1,600	2,100	0	2,100	20,500	3.3	400	2,500
8b*	DA-16	545.7	See the TSCA Tables for the volumes of this DMU	1,300	0	1,300	0	1,300	5,600	6.8	100	1,400
8c	R-15	545.7	to till, to 5 ft of noncritical structure	3,200	1,000	2,200	0	2,200	27,100	2.7	500	2,700
9	DA-15	545.7	to till, to 5 ft of noncritical structure	25,700	12,200	13,500	400	13,100	69,600	5.6	1,300	14,400
10		545.7	to till, to 20ft of critical structure	18,700	7,000	11,700	1,800	9,900	71,100	4.3	1,300	11,200
11	DA-14	545.7	to till, to riprap	30,200	12,500	17,700	500	17,200	113,100	4.6	2,100	19,300
12		545.7		20,500	10,000	10,500	600	9,900	57,900	5.1	1,100	11,000
13		545.7		7,800	4,100	3,700	200	3,500	39,000	2.9	700	4,200
14		545.7		7,000	4,200	2,800	100	2,700	43,800	2.2	800	3,500
15		545.7		18,700	11,400	7,300	100	7,200	67,700	3.4	1,300	8,500
16	DA-13	545.7	to till	5,900	1,200	4,700	0	4,700	50,900	3.0	900	5,600
17		545.7	to till, to no dredge boundary	14,400	6,700	7,700	2,100	5,600	65,300	2.8	1,200	6,800
18		545.7	no dredge zone	14,700	500	14,200	13,300	900	5,400	5.0	100	1,000
19	R-14	545.7	to till, to no dredge boundary	8,100	2,600	5,500	3,200	2,300	29,200	2.6	500	2,800
20	DA-12	545.7	to till	12,300	6,700	5,600	0	5,600	64,100	2.9	1,200	6,800
21		545.7	to till	11,100	3,900	7,200	0	7,200	56,500	3.9	1,000	8,200
22	R-13	545.7	to till	19,100	8,500	10,600	0	10,600	85,900	3.8	1,600	12,200
23	DA-11	545.7	to till	4,400	2,000	2,400	0	2,400	16,500	4.4	300	2,700
24		545.7	to till, to 5 ft of noncritical structure	12,200	6,700	5,500	0	5,500	51,100	3.4	900	6,400
25		545.7	to till	17,000	8,800	8,200	0	8,200	81,600	3.2	1,500	9,700
26		545.7	to till	7,800	2,100	5,700	0	5,700	41,100	4.3	800	6,500
27		545.7	to till, to no dredge boundary	11,600	2,100	9,500	2,300	7,200	43,300	5.0	800	8,000
28	DA-11	545.7	no dredge zone	13,600	0	13,600	13,600	0	100	0.0	0	0
29		545.7	to till, to no dredge boundary	7,900	800	7,100	1,600	5,500	40,700	4.2	800	6,300
30	DA-11	545.7	to till	12,200	2,900	9,300	0	9,300	53,100	5.2	1,000	10,300
31		545.7	to till	23,800	6,700	17,100	0	17,100	84,300	6.0	1,600	18,700
32		545.7	to till	34,000	8,300	25,700	100	25,600	123,600	6.1	2,300	27,900
33		545.7	to till	13,400	800	12,600	2,100	10,500	75,700	4.2	1,400	11,900
34		545.7	to till	10,900	300	10,600	200	10,400	53,300	5.8	1,000	11,400
35		545.7	to till	11,200	2,400	8,800	1,500	7,300	56,400	4.0	1,000	8,300
36		545.7	to till	21,500	3,300	18,200	1,400	16,800	86,300	5.8	1,600	18,400
37a	DA-18	545.7	no dredge zone	3,100	600	2,500	2,500	0	0	0.0	0	0
37b	R-12	545.7	No environmental dredging									
37c	DA-10	545.7	to till from 30 ft downstream of critical structure only	15,400	7,200	8,200	4,000	4,200	23,000	5.4	400	4,600

Table 2. Final Design Volume Estimates by Dredge Management Unit (DMU)

last update: 2/25/2013

DMU No.	Dredge Area Name	USACE Dredge Depth	EPA Dredge Depth	DMU Total Dredge Volume	USACE Dredge Volume (cy)	Total EPA Dredge Volume (cy)	Potential Undredged Volume (total DMU) (cy)	Potential Dredged Volume (cy)	DMU Dredge Surface Area (ft²)	Average Dredge Depth (ft)	Allowable Over-dredge Volume (cy)	Operational Dredge Volume (cy)	
38	DA-9	545.7	to till on noncritical structure side of the river	23,500	5,700	17,800	4,800	13,000	111,300	3.7	2,100	15,100	
39		545.7	only	24,000	6,700	17,300	8,100	9,200	89,700	3.3	1,700	10,900	
40		545.7	to till	7,400	200	7,200	0	7,200	90,500	2.7	1,700	8,900	
41	DA-8	545.7	to till, to 5 ft of noncritical structure	13,900	3,300	10,600	100	10,500	79,300	4.1	1,500	12,000	
42		545.7	to till, to 5 ft of noncritical structure	16,300	2,200	14,100	400	13,700	110,500	3.8	2,000	15,700	
43		545.7	to till	10,700	700	10,000	100	9,900	51,200	5.7	900	10,800	
44a	R-11	--	no dredge zone	700	0	700	0	700	0	0.0	0	700	
44b	R-10	--	No environmental dredging										
44c	R-09	--	No environmental dredging										
44d	R-08	545.7	No environmental dredging										
44e	DA-07	545.7	to till, to 5 ft of noncritical structure	17,700	500	17,200	400	16,800	25,600	18.2	500	17,300	
44f	R-07	--	to till	2,400	100	2,300	0	2,300	36,100	2.2	700	3,000	
45a	R-06	545.7	to till, to 5 ft of noncritical structure	1,400	200	1,200	0	1,200	12,200	3.1	200	1,400	
45b	R-05	--	to till, to structure	900	0	900	0	900	4,600	0.0	100	1,000	
45c	DA-05	545.7	to till	16,800	3,400	13,400	9,600	3,800	24,700	4.7	500	4,300	
45d	DA-06	545.7	no dredge zone	6,800	4,300	2,500	2,500	0	0	0.0	0	0	
45e	R-04	545.7	to till, to 5 ft of noncritical structure	1,200	200	1,000	0	1,000	4,600	6.5	100	1,100	
Totals:				656,800	189,500	467,300	96,700	370,600	2,751,900	4.98	51,100	421,700	
Additional dredging based on confirmation sampling												0	
Sedimentation (Year 1)												10,000	
Sedimentation (Year 2)												30,000	
												461,700	
												462,000	
Rounded Volume													
Volume Range (Rounded)												439,000	485,000

* The volume is shown for Non-TSCA material in DMU-8b. The estimated volume of TSCA material is 4200 cy.

Notes:

* The volume is shown for Non-TSCA material in DMU-8b. The estimated volume of TSCA material is 4200 cy.

Notes:

- Volume estimates are presented in cubic yards (cy), rounded to the nearest 100 cy.
- USACE Dredge Depth** based on USACE contract drawing C-102, and is the depth beneath low water datum of 569.2'.
- EPA Dredge Depth** based on evaluation of till elevation measurements within the DMU and presence of structures (critical and non-critical) which affect potential dredge prisms.
- DMU Total Dredge Volume** based on a total volume within a DMU between the EPA dredge depth and current (2010) bathymetric surface.
- DMUs 4b, 7b, 37b, 44b, 44c, and 44d (Resample Areas R-1, R-3, R-12, R-10, R-9, and R-8 respectively) will not be dredged based on the DMU evaluations.
- USACE Dredge Volume** was calculated by the difference between the bathymetric surface and USACE Dredge Prism within the DMU boundaries (assuming a 1H:1V side slope and dredge depth to elevation 545.7'). No overdredging of USACE dredge prism was assumed. Refer to USACE contract drawing C-101.
- Total EPA Dredge Volume** is the difference between the **DMU Total Dredge Volume** and the **USACE Dredge Volume**.
- Potential Undredged Volume** is the volume of sediment assumed to be left in place without bank stabilization and assuming 1H:1V side slopes or estimated remaining material at critical structures based on CAD calculations of no dredge zones
- Potential Dredge Volume** is the difference between **Total EPA Dredge Volume** and **Potential Undredged Volume**.
- Dredge Surface Area** is the **Total DMU surface area adjusted for no dredge boundaries**.
- Allowable Over-Dredge Volume** was estimated as 6" thick over each DMU area. This volume is the overdredge volume for which the contractor will be reimbursed.
- Operational Dredge Volume** was the **Potential Dredge Volume** plus the **Allowable Over-Dredge Volume**.

TABLE 3

Property Owners and Shoreline Structures

BODR Buffalo River AOC, Buffalo, New York

SBL	Owner	Address	Shoreline Type	Figure Key	Length (feet)
122.05-11-1.21	175 OHIO STREET LLC	175 OHIO	Stone Filled Timber Crib (SFC)	(SFC)	159
122.05-12-5	GENERAL MILLS PROPERTIES INC	4 CITY SHIP CANAL	Anchored Steel Sheet Pile Wall (ASP)	(ASP)	87
122.05-12-5	GENERAL MILLS PROPERTIES INC	4 CITY SHIP CANAL	Concrete Pier Crib Wall (CPCW)	(CPCW)	325
122.05-13-1.1	POWER AUTHORITY OF THE STATE OF NEW YORK	32 FUHRMANN	Aluminum/Wood Boat Docks (AWB)	(AWB)	164
122.05-13-1.1	POWER AUTHORITY OF THE STATE OF NEW YORK	32 FUHRMANN	Boat Ramp (BR)	(BR)	53
122.05-13-1.2	SHIP CANAL PROPERTIES INC	9 CITY SHIP CANAL	Aluminum/Wood Boat Docks (AWB)	(AWB)	331
122.05-13-2.1	BUFFALO SAILING MARINA INC	5 CITY SHIP CANAL	Naturally and Stone Sloped Shore (NSS)	(NSS)	11
122.09-1-2.121	SHIP CANAL PROPERTIES INC	11 CITY SHIP CANAL	Aluminum/Wood Boat Docks (AWB)	(AWB)	710
122.09-1-2.121	SHIP CANAL PROPERTIES INC	11 CITY SHIP CANAL	Naturally and Stone Sloped Shore (NSS)	(NSS)	40
122.09-1-3	GENERAL MILLS PROPERTIES INC	6 CITY SHIP CANAL	Naturally Sloped Shore with Timber Piles (NST)	(NST)	513
122.09-1-5	PILLSBURY MILLS INC; ADM MILLING CO	8 CITY SHIP CANAL	Large Diameter Steel Sheet Pile Cells (LD)	(LD)	830
122.09-1-5	PILLSBURY MILLS INC; ADM MILLING CO	8 CITY SHIP CANAL	Steel H Piles with Concrete Cap (SHPC)	(SHPC)	210
122.09-1-5	PILLSBURY MILLS INC; ADM MILLING CO	8 CITY SHIP CANAL	Steel Sheet Pile with Concrete Cap (SPC)	(SPC)	129
122.10-2-7.21	PALADINO REVOCABLE TRUST CARL MAGNANO LOUIS 1/2 INT.	399 OHIO	Naturally Sloped Shore with Timber Piles (NST)	(NST)	70
122.10-2-7.21	PALADINO REVOCABLE TRUST CARL MAGNANO LOUIS 1/2 INT.	399 OHIO	Steel Sheet Pile Wall (SSPW)	(SSPW)	469
122.10-2-8.2	NYS DEPARTMENT ENVIRONMENTAL CONSERVATIO	421 OHIO	Steel Sheet Pile Wall (SSPW)	(SSPW)	33
122.13-2-3.1	PORT CRESCENT LAND CO	13 CITY SHIP CANAL	Timber Wharf on Timber Pile (TWTP)	(TWTP)	471
122.13-2-4.1	CON-RAIL NON-TRANS	702 FUHRMANN	Grouted Slope Shoreline (GSS)	(GSS)	569
122.13-3-1	CSX TRANSPORTATION INC	0	Cobble, Gravel, and Debris Shoreline (CGDS)	(CGDS)	661
122.15-1-1.1	BOC GROUP INC (THE)	95 KATHERINE	RR Abutment (RRA)	(RRA)	96
122.15-1-1.2	THE BOC GROUP INC	89 KATHERINE	Naturally Sloped Shore (NS)	(NS)	1230
122.15-1-2	CITY OF BUFFALO DIV OF REAL ESTATE	61 BUFFALO RIVER	RR Abutment (RRA)	(RRA)	86
122.15-1-4.1	COUNTY OF ERIE	20 SMITH	Concrete Wall (CW)	(CW)	13
122.15-1-4.1	COUNTY OF ERIE	20 SMITH	Naturally Sloped Shore (NS)	(NS)	578
122.15-2-2.1	CON-RAIL NON-TRANS	181 BUFFALO RIVER	Naturally Sloped Shore (NS)	(NS)	142
122.15-2-2.1	CON-RAIL NON-TRANS	181 BUFFALO RIVER	Steel Sheet Pile Wall (SSPW)	(SSPW)	156
122.15-2-2.2	CON-RAIL NON-TRANS	191 BUFFALO RIVER	Naturally Sloped Shore (NS)	(NS)	137
122.15-2-2.2	CON-RAIL NON-TRANS	191 BUFFALO RIVER	Naturally Sloped Shore (NS)	(NS)	142

TABLE 3

Property Owners and Shoreline Structures

BODR Buffalo River AOC, Buffalo, New York

SBL	Owner	Address	Shoreline Type	Figure Key	Length (feet)
122.15-2-2.3	CSX TRANSPORTATION INC	0	Concrete Wall (CW)	(CW)	12
122.16-1-1.111	P.V.S. CHEMICALS INC C/O ATTN: CONTROLLER	55 LEE	Concrete Wall (CW)	(CW)	98
122.16-1-1.111	P.V.S. CHEMICALS INC C/O ATTN: CONTROLLER	55 LEE	Naturally and Stone Sloped Shore (NSS)	(NSS)	98
122.16-1-1.111	P.V.S. CHEMICALS INC C/O ATTN: CONTROLLER	55 LEE	Naturally and Stone Sloped Shore (NSS)	(NSS)	136
122.16-1-10	SOUTH BUFFALO DEVELOPMENT LLC	2 BUFFALO CREEK RR	Naturally and Stone Sloped Shore (NSS)	(NSS)	75
122.16-1-10	SOUTH BUFFALO DEVELOPMENT LLC	2 BUFFALO CREEK RR	Riprap (RPRP)	(RPRP)	162
122.16-1-10	SOUTH BUFFALO DEVELOPMENT LLC	2 BUFFALO CREEK RR	Steel Sheet Pile Wall (SSPW)	(SSPW)	24
122.16-1-10	SOUTH BUFFALO DEVELOPMENT LLC	2 BUFFALO CREEK RR	Timber Bulkhead (TB)	(TB)	25
122.16-1-13.1	NIAGARA FRONTIER TRANSPORTATION AUTHORITY	61 SMITH	Concrete Wall (CW)	(CW)	139
122.16-1-13.1	NIAGARA FRONTIER TRANSPORTATION AUTHORITY	61 SMITH	Naturally Sloped Shore (NS)	(NS)	1014
122.16-1-16	BUFFALO ECONOMIC RENAISSANCE CORPORATION	1176 SOUTH PARK	Naturally and Stone Sloped Shore (NSS)	(NSS)	195
122.16-1-8.1	RIVERBEND LLC	1339 SOUTH PARK	Steel Sheet Pile Wall (SSPW)	(SSPW)	324
122.16-1-9	SOUTH BUFFALO DEVELOPMENT LLC	1337 SOUTH PARK	Anchored Concrete Sheet Wall (AC)	(AC)	175
122.16-1-9	SOUTH BUFFALO DEVELOPMENT LLC	1337 SOUTH PARK	Concrete Cap on Timber Piles (CCT)	(CCT)	106
122.18-1-1	CON-RAIL NON-TRANS	748 FUHRMANN	Grouted Slope Shoreline (GSS)	(GSS)	262
122.18-1-2	CSX TRANSPORTATION INC	0	Cobble, Gravel, and Debris Shoreline (CGDS)	(CGDS)	188
122.18-1-2	CSX TRANSPORTATION INC	0	Concrete Wall (CW)	(CW)	368
122.18-1-2	CSX TRANSPORTATION INC	0	Naturally Sloped Shore (NS)	(NS)	1196
122.18-1-2	CSX TRANSPORTATION INC	0	Riprap (RPRP)	(RPRP)	84
122.18-1-2	CSX TRANSPORTATION INC	0	Riprap (RPRP)	(RPRP)	546
122.18-1-2	CSX TRANSPORTATION INC	0	Steel Sheet Pile Wall (SSPW)	(SSPW)	155
122.18-2-5	ADVANCE METALS RECYCLING C/O GERDAU AMERISTEEL TAX DEPT	169 BUFFALO RIVER	Concrete Cap on Timber Piles (CCT)	(CCT)	354
122.18-2-5	ADVANCE METALS RECYCLING C/O GERDAU AMERISTEEL TAX DEPT	169 BUFFALO RIVER	Concrete Cap on Timber Piles (CCT)	(CCT)	298
122.18-2-5	ADVANCE METALS RECYCLING C/O GERDAU AMERISTEEL TAX DEPT	169 BUFFALO RIVER	Naturally and Stone Sloped Shore (NSS)	(NSS)	144
122.18-3-1.1	STIMM ASSOC. INC.	100 KATHERINE	Naturally Sloped Shore with Timber Piles (NST)	(NST)	178

TABLE 3

Property Owners and Shoreline Structures

BODR Buffalo River AOC, Buffalo, New York

SBL	Owner	Address	Shoreline Type	Figure Key	Length (feet)
122.18-3-2.1	STIMM ASSOCIATES INC. CORP	20 KATHERINE	Naturally Sloped Shore with Timber Piles (NST)	(NST)	434
122.19-1-3.212	SIKORSKI RICHARD	51 KATHERINE	Cobble and Gravel Shoreline (CGS)	(CGS)	74
122.19-1-3.22	OLROGGE HENRY	47 ENSIGN	Naturally Sloped Shore (NS)	(NS)	207
122.19-1-3.22	OLROGGE HENRY	47 ENSIGN	Timber Bulkhead (TB)	(TB)	325
122.19-1-4	CITY OF BUFFALO DIV OF REAL ESTATE	55 BUFFALO RIVER	Cobble, Gravel, and Debris Shoreline (CGDS)	(CGDS)	268
122.19-1-4	CITY OF BUFFALO DIV OF REAL ESTATE	55 BUFFALO RIVER	Naturally Sloped Shore (NS)	(NS)	63
122.19-2-6	NORFOLK SOUTHERN CORP. BOX 28	9999 NORFOLK RR	Concrete Wall (CW)	(CW)	79
122.20-1-1	BALTIMORE & OHIO RR	0	Naturally Sloped Shore with Timber Piles (NST)	(NST)	543

Figures



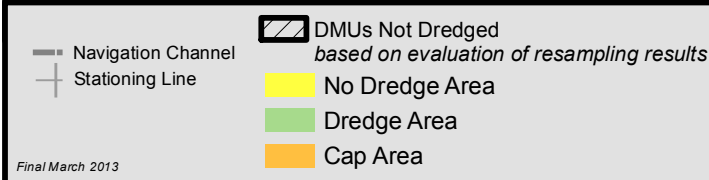
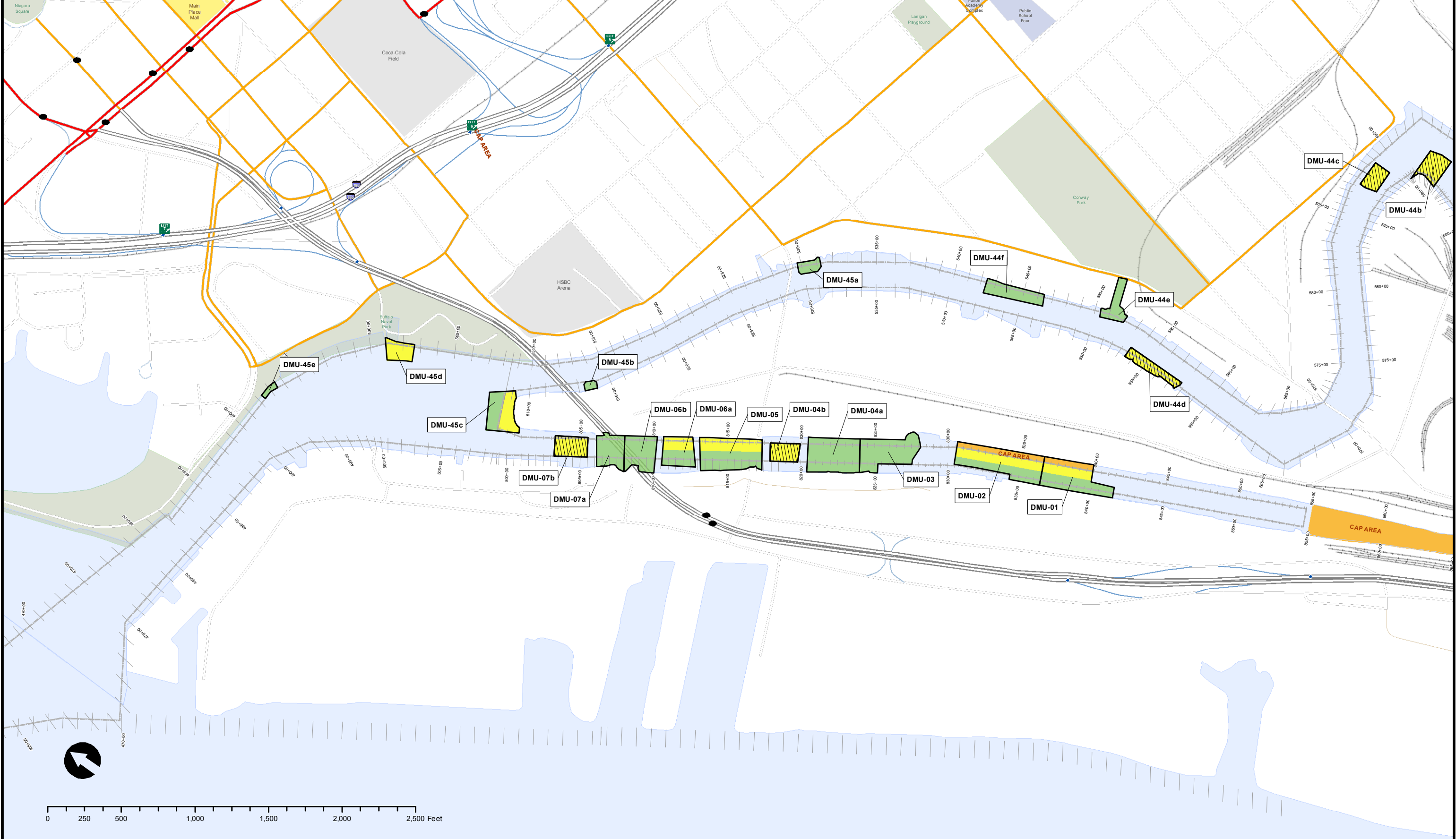
Source: NYSDEC, 2008
CUGIR, 2008

Approximate Perimeter
of Buffalo River AOC

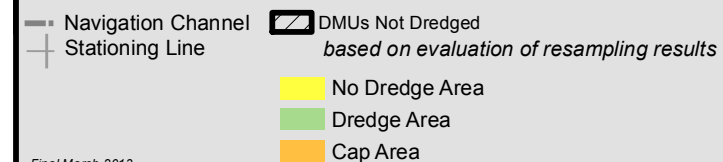
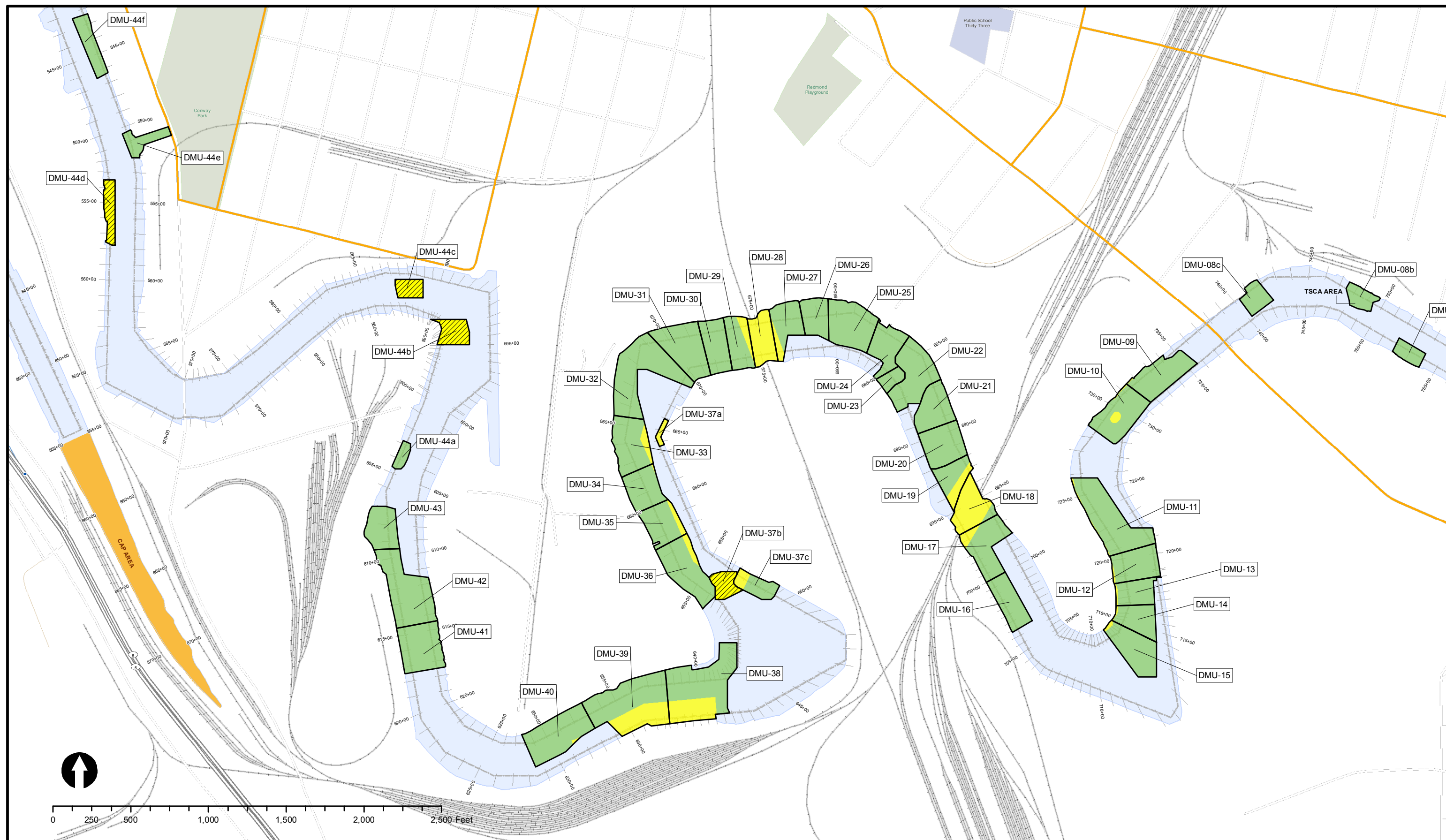


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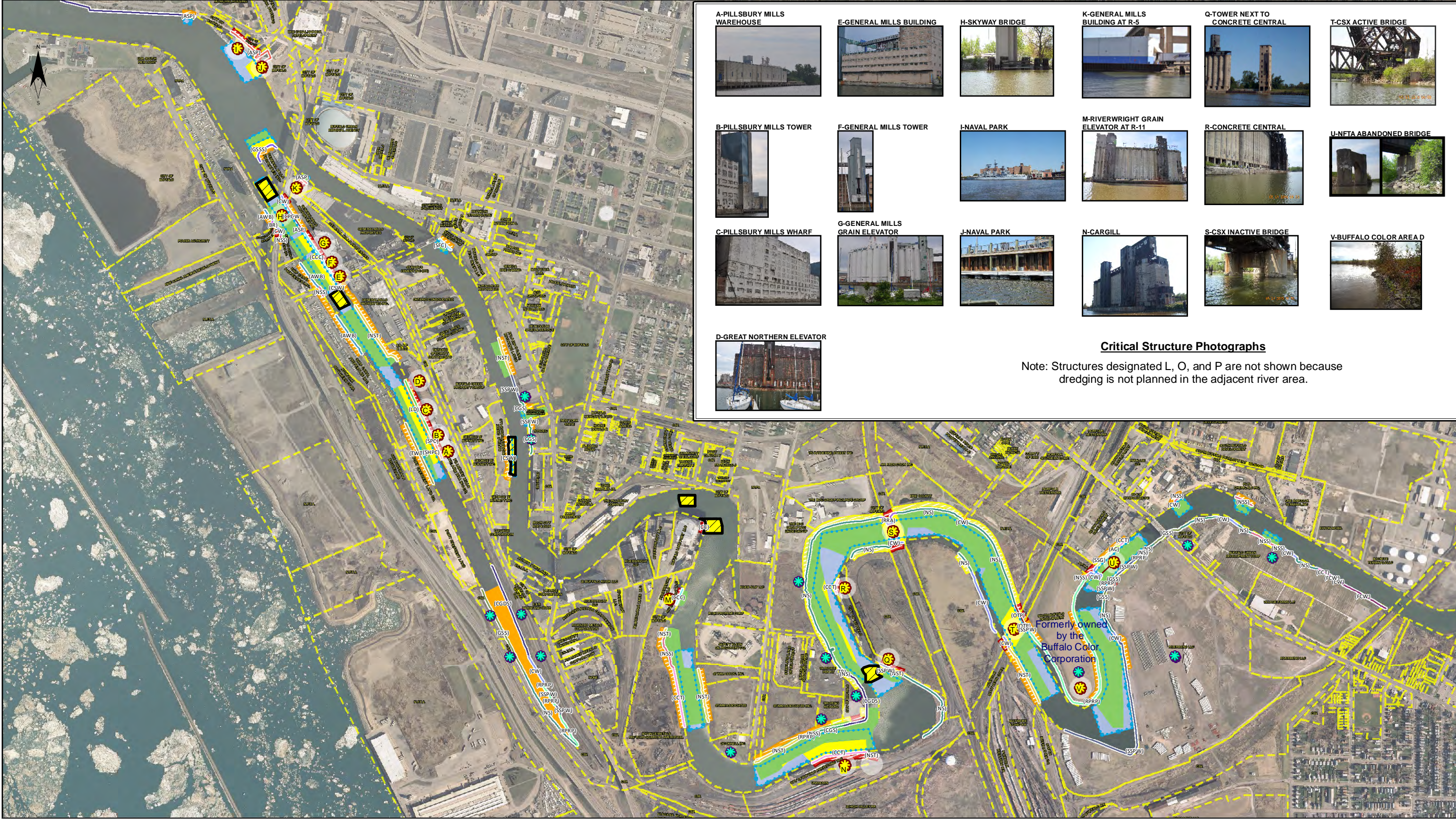
Figure 1
Site Location Map
Buffalo River AOC
Buffalo, NY



**Figure 2 DMU and Resample Area Locations,
Western Portion
Buffalo River AOC Remedial Design
Buffalo, New York**



**Figure 3 Dredge Management Unit Locations
Eastern Portion, Buffalo River AOC
Buffalo, New York**



A-PILLSBURY MILLS WAREHOUSE



E-GENERAL MILLS BUILDING



H-SKYWAY BRIDGE



K-GENERAL MILLS BUILDING AT R-5



Q-TOWER NEXT TO CONCRETE CENTRAL



T-CSX ACTIVE BRIDGE



B-PILLSBURY MILLS TOWER



F-GENERAL MILLS TOWER



I-NAVAL PARK



M-RIVERWRIGHT GRAIN ELEVATOR AT R-11



R-CONCRETE CENTRAL



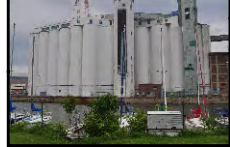
U-NFTA ABANDONED BRIDGE



C-PILLSBURY MILLS WHARF



G-GENERAL MILLS GRAIN ELEVATOR



J-NAVAL PARK



N-CARGILL



S-CSX INACTIVE BRIDGE



V-BUFFALO COLOR AREA D



D-GREAT NORTHERN ELEVATOR



Critical Structure Photographs

Note: Structures designated L, O, and P are not shown because dredging is not planned in the adjacent river area.

DMUs Not Dredged

based on evaluation of resampling results

Critical Structure



Potential Habitat Restoration Shore



USACE GLRI 2011 Dredge Boundary



Parcel

Shoreline Classification

Critical Structure

Earth Retaining or Other Structure

Naturally Sloped Shore

Shoreline Type

Aluminum/Wood Boat Docks (AWB)

Anchored Concrete Sheet Wall (AC)

Anchored Steel Sheet Pile Wall (ASP)

Boat Ramp (BR)

Cobble and Gravel Shoreline (CGS)

Cobble, Gravel, and Debris Shoreline (CGDS)

Concrete Cap (CC)

Concrete Cap on Timber Piles (CCT)

Concrete Pier Crib Wall (CPCW)

Concrete Piles and Cap (CCC)

Concrete Wall (CW)

Cut Stone Wall (CSW)

Failing Concrete Wall (FCW)

Grouted Slope Shoreline (GSS)

Grouted Sloped Stone Shore (GSSS)

Large Diameter Steel Sheet Pile Cells (LD)

Naturally Sloped Shore (NS)

Naturally Sloped Shore with Timber Piles (NST)

Naturally and Stone Sloped Shore (NSS)

Old Timber Piles (OTP)

RR Abutment (RRA)

Riprap (RPRP)

Sloped Stone Gabion (SSG)

Steel H Piles with Concrete Cap (SHPC)

Steel Sheet Pile Wall (SSPW)

Steel Sheet Pile with Concrete Cap (SPC)

Stone Filled Timber Crib (SFC)

Timber Bulkhead (TB)

Timber Wharf on Timber Pile (TWTP)

Note: Shoreline types are based on visual observations, and limited historical information.

Figure 4 Critical Structures and Shoreline Classifications, Buffalo River AOC

0 500 1,000 2,000 Feet